



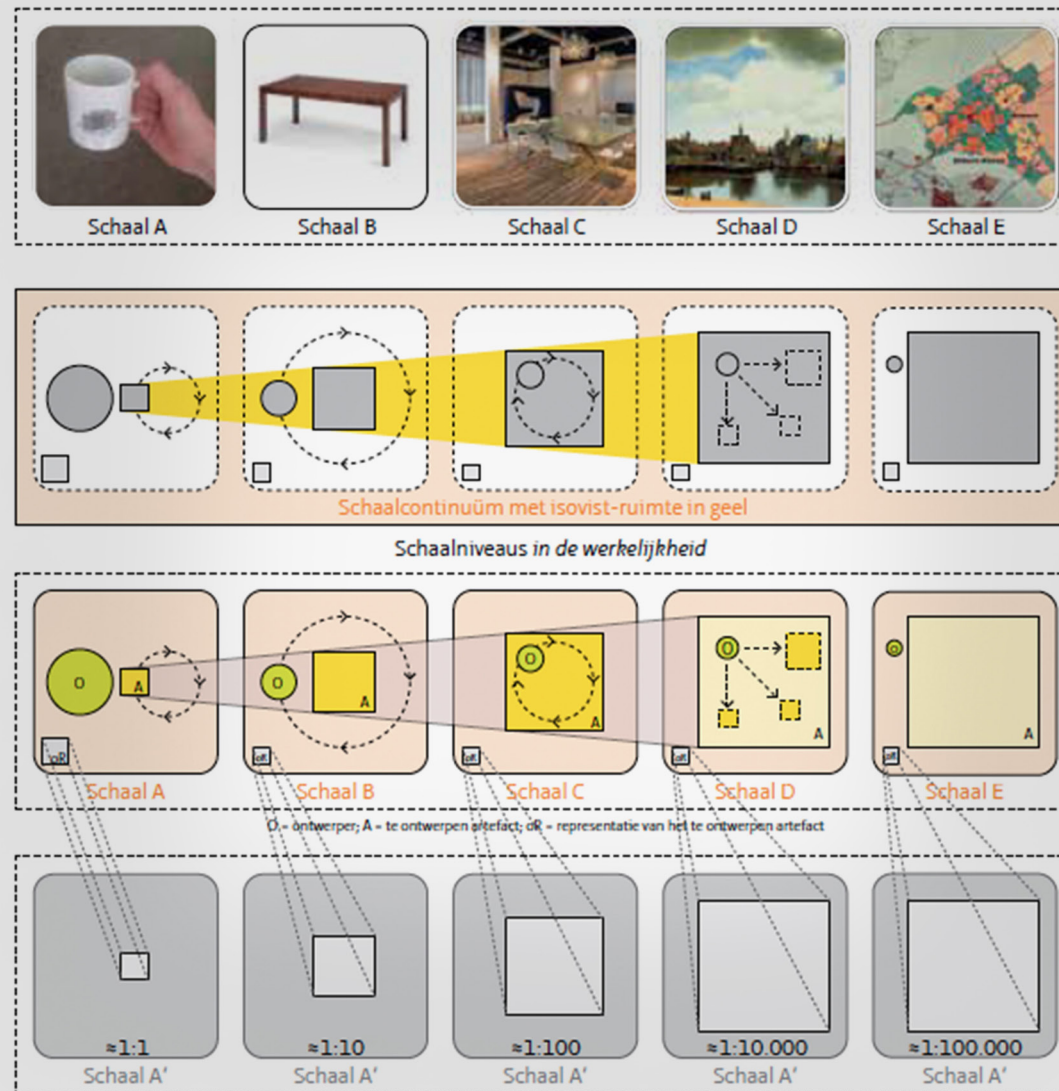
Perceiving Liveability through
Objective Technology

Müdat Deniz
Şükür
AR4U100
MSc graduation
project

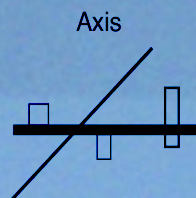
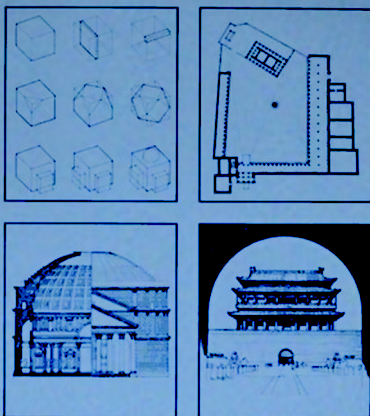
introduction

Why this research?

Generic design characteristics are ill-defined and unstructured or untamed and hard to evaluate in advance.



**ARCHITECTURE:
FORM • SPACE
& ORDER**
FRANCIS DK. CHING



Axis

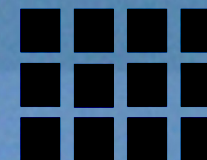
Hierarchy



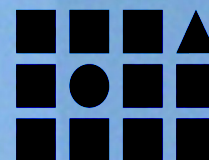
Contrast



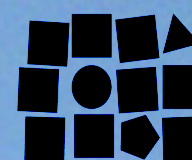
Rhythm/Repetition



Datum



Complexity



Transformation

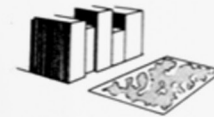
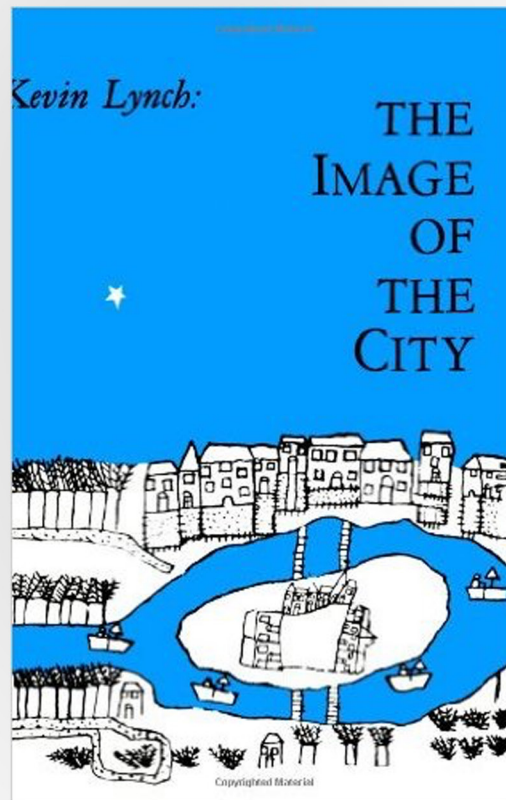


A Pattern Language
Towns · Buildings · Construction



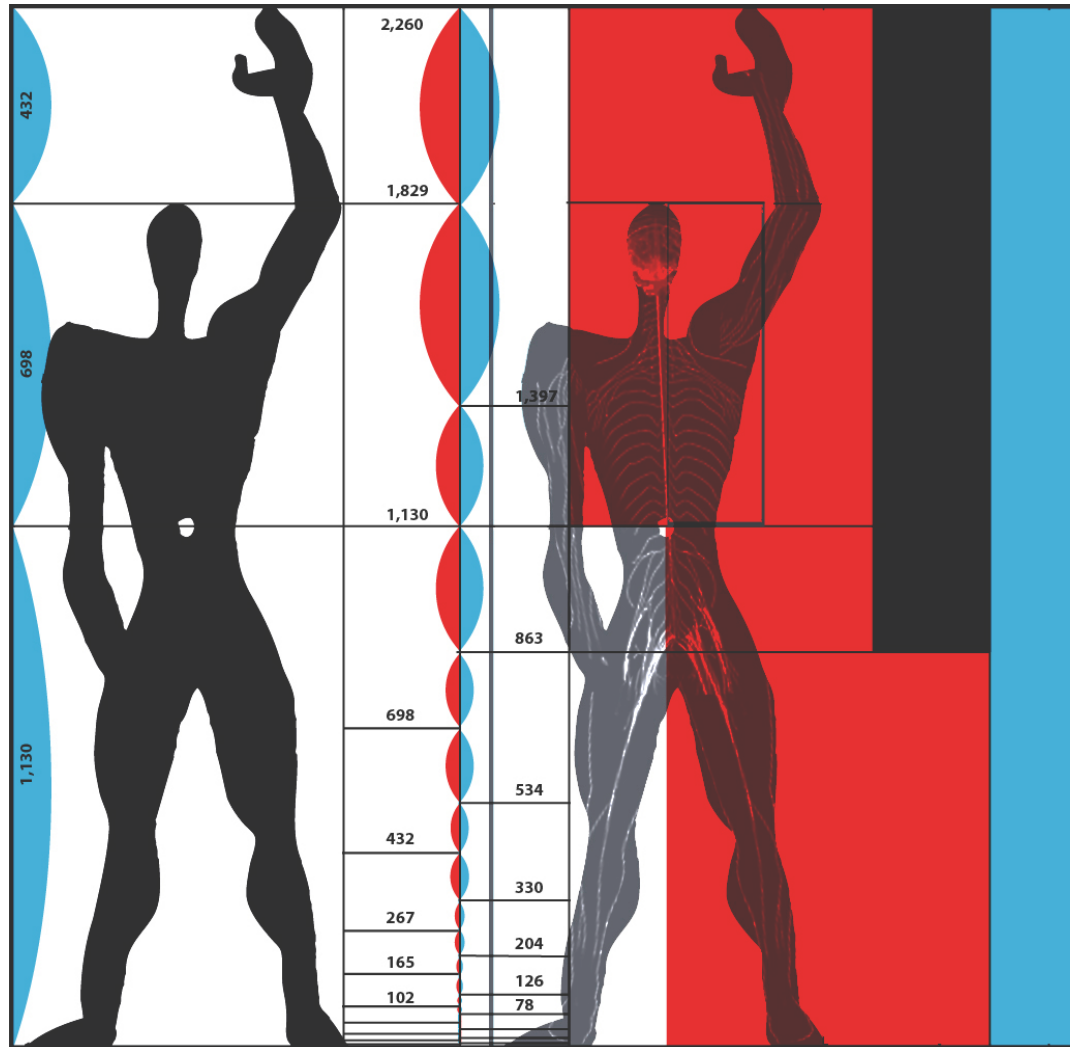
Christopher Alexander
Sara Ishikawa · Murray Silverstein
WITH
Max Jacobson · Ingrid Fiksdahl-King
Shlomo Angel

but...
there is a
common language



and a
mental
image

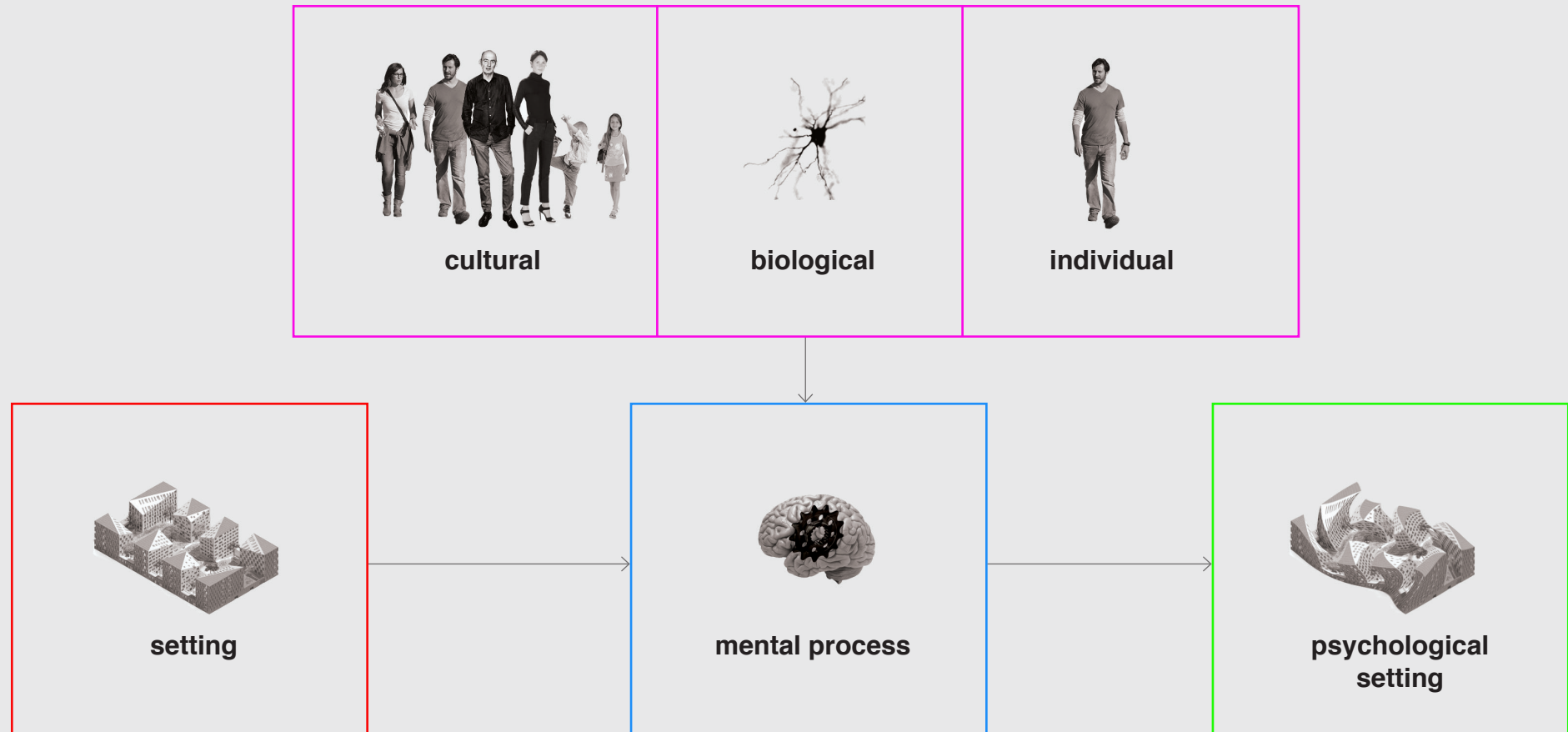
Evaluation relates to people's **perception**



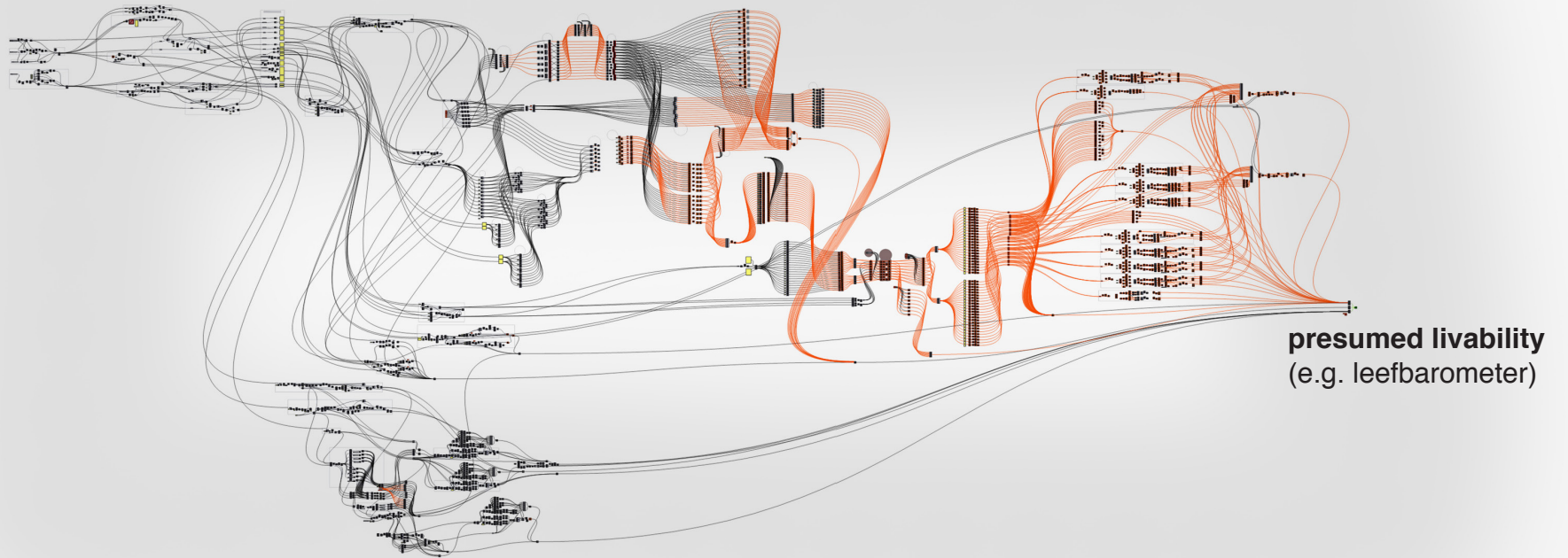
“the human scale”

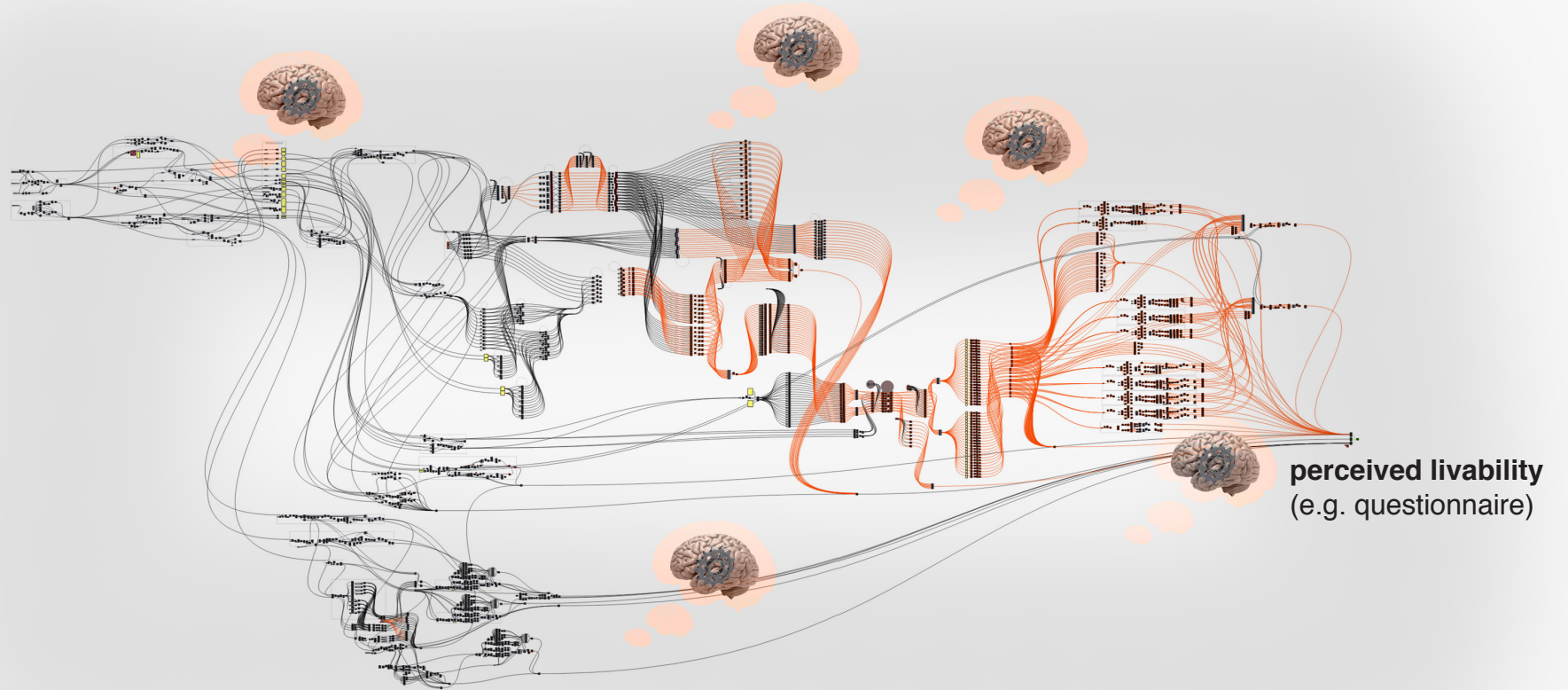
But the problem is...

it is complex



it is biased





is it possible with objective technology..?



this research aims to...

Better understand how we visually perceive urban environments (evidence based, rather than presumed expert/picturesque approach)

Explore cross-disciplinary methods (EEG & eye-tracking) in environmental psychology & urban design

Centralize human perception, and make it more explicit in urban design

Develop a visual-perceptual urban design guideline that helps designing harmonious urban environments

Illustrate how these guidelines can be expressed in urban design

outline

PART I

Research question & definitions

Theoretical framework

PART II

Exploring methods

Analysis & results

PART III

Express results in design: example cases

Conclusions

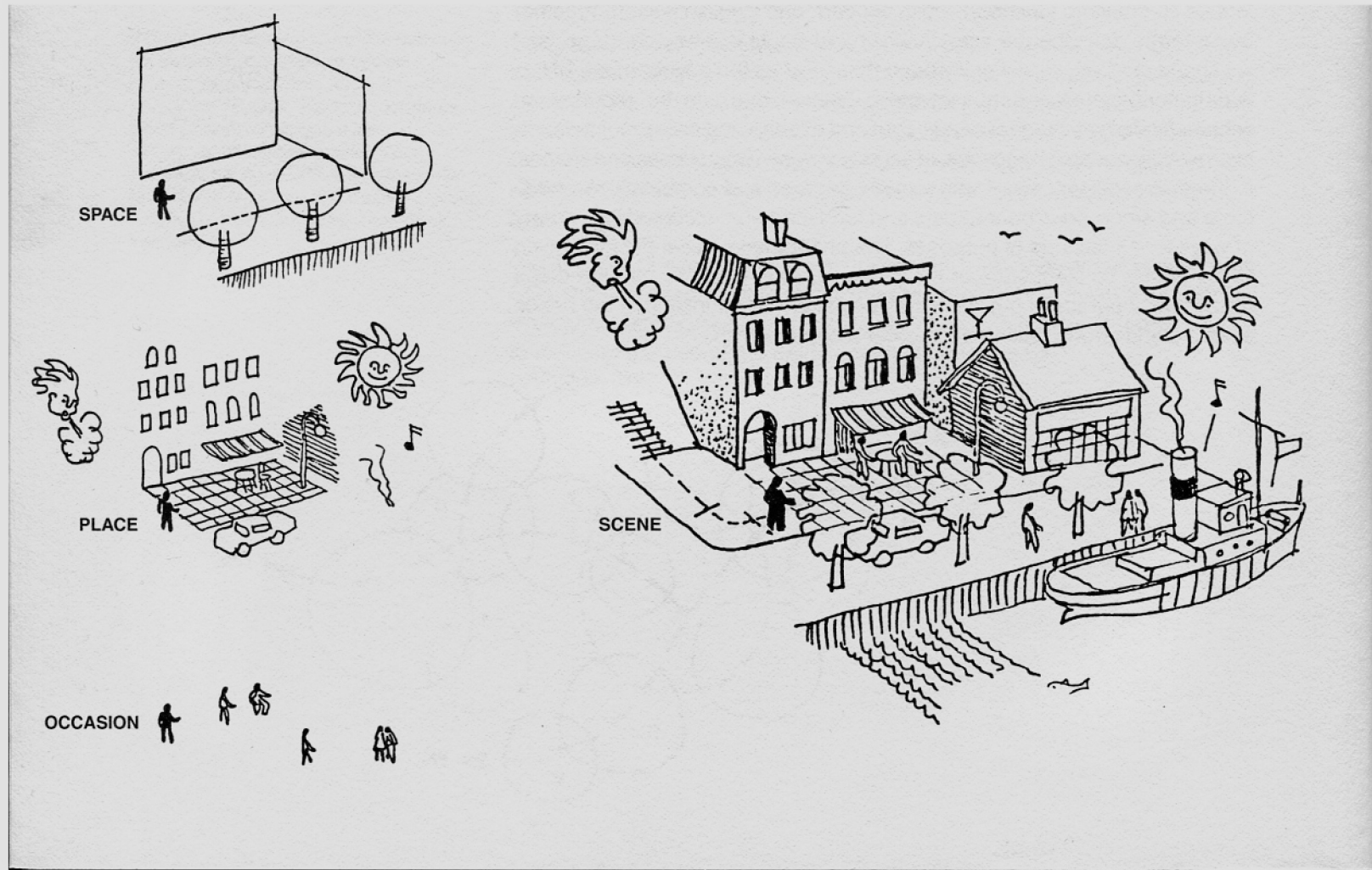
research question

Which **spatial elements** are essential in influencing our visual **perception** of **urban environments**, and how can we explicate and express these elements in **urban design**?

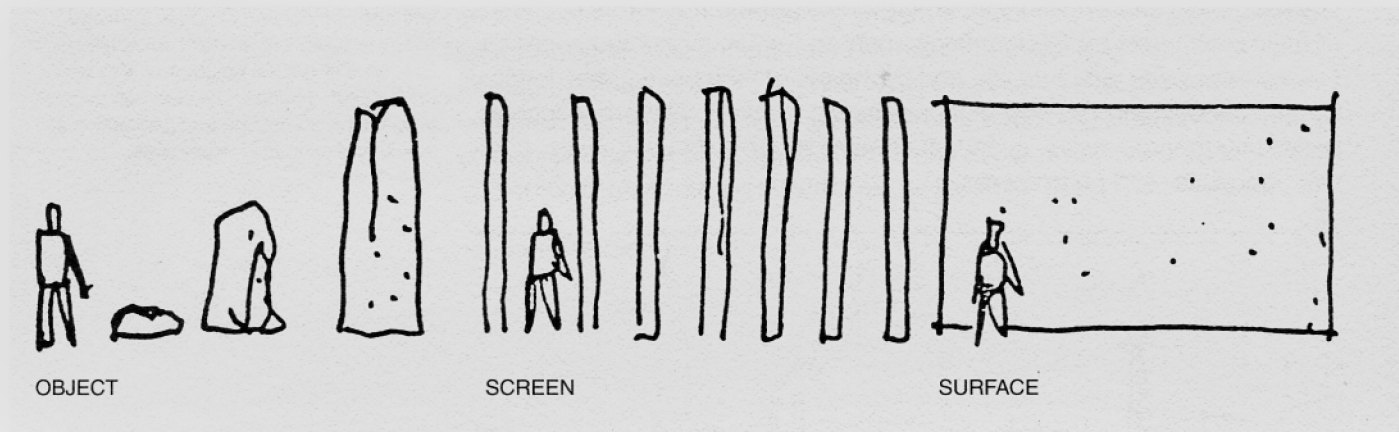
Let's define the question...

theoretical framework

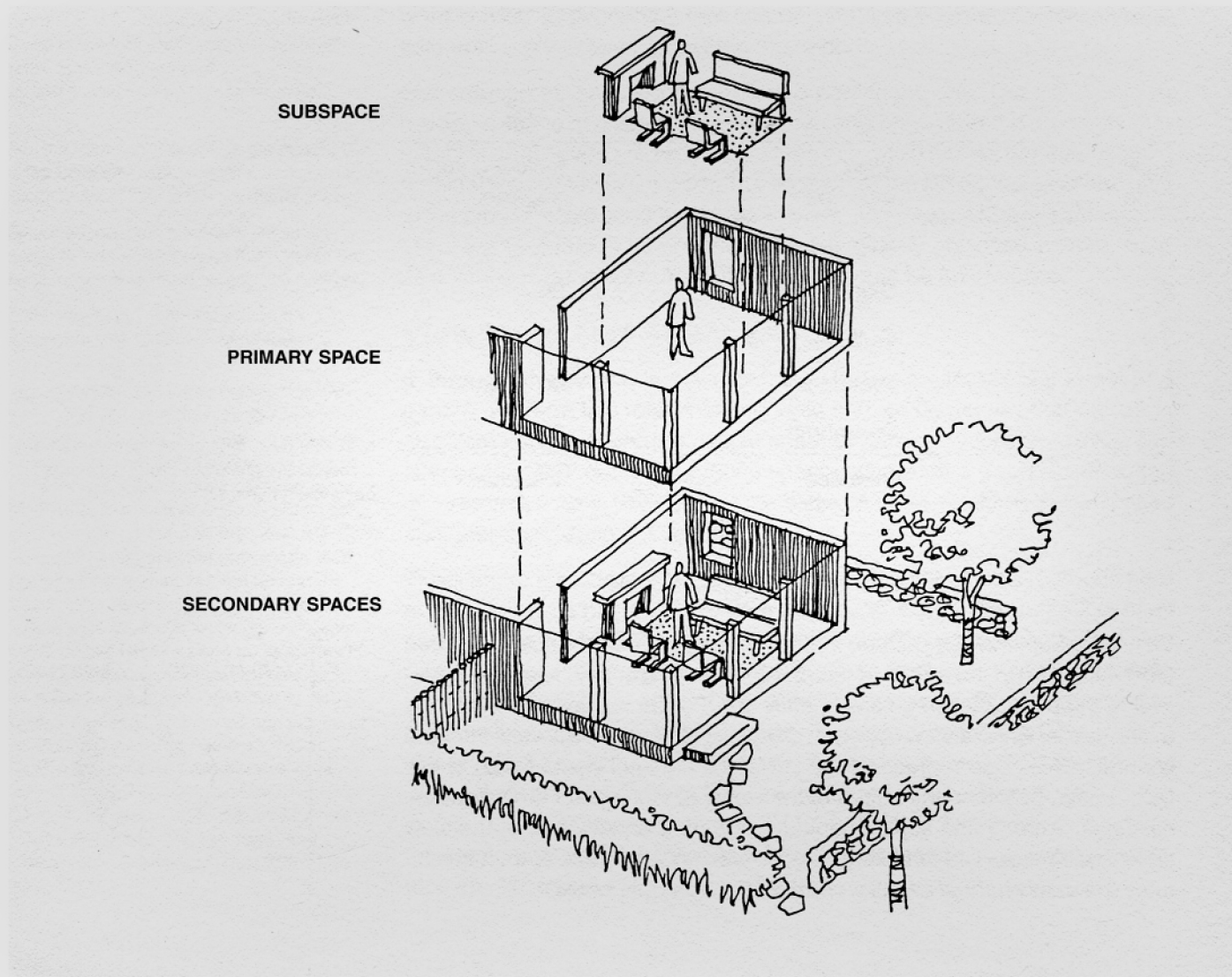
spatial elements



SEE's

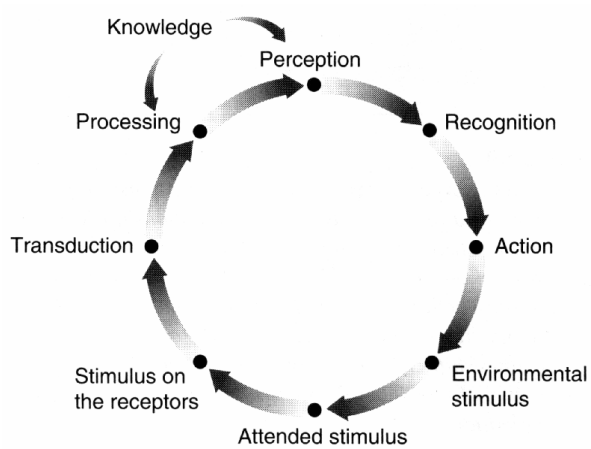


space - in space



Perception (derived from Latin words perceptio or percipio) is the **organisation, identification, and interpretation of sensory information** in order to **represent and understand** the environment (Schacter et al., 2011)

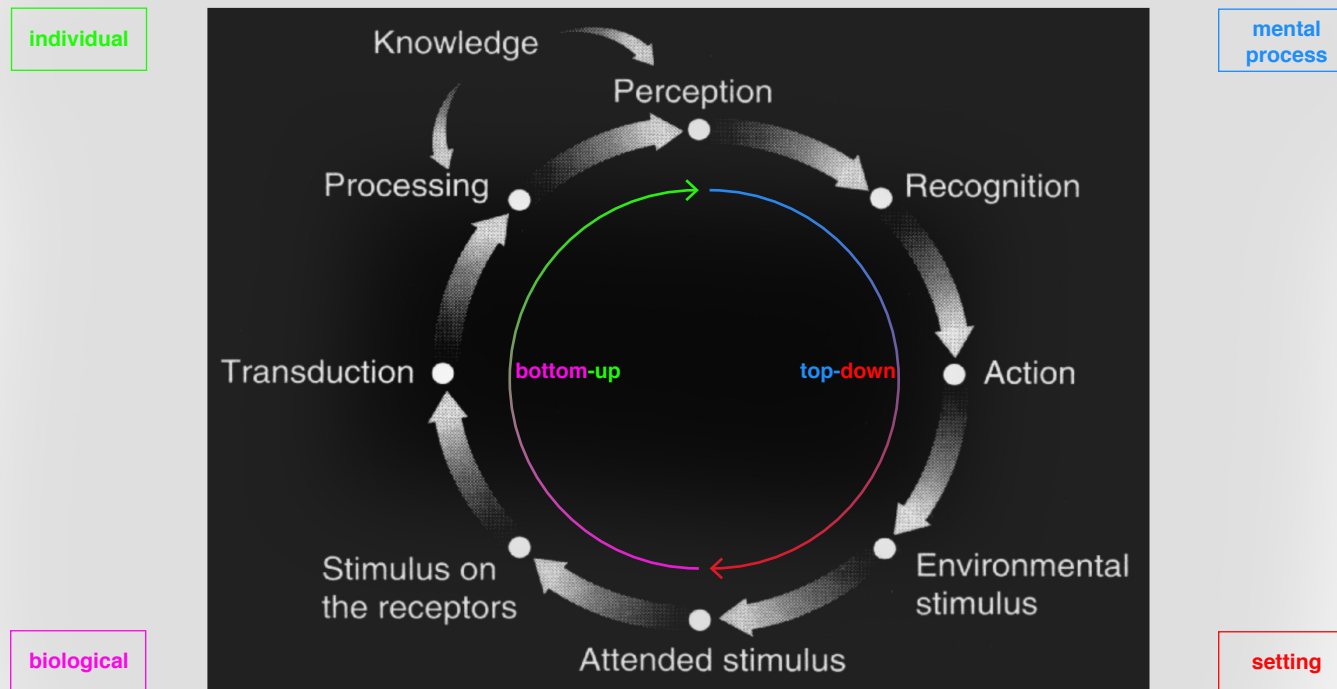
Perceptual cycle



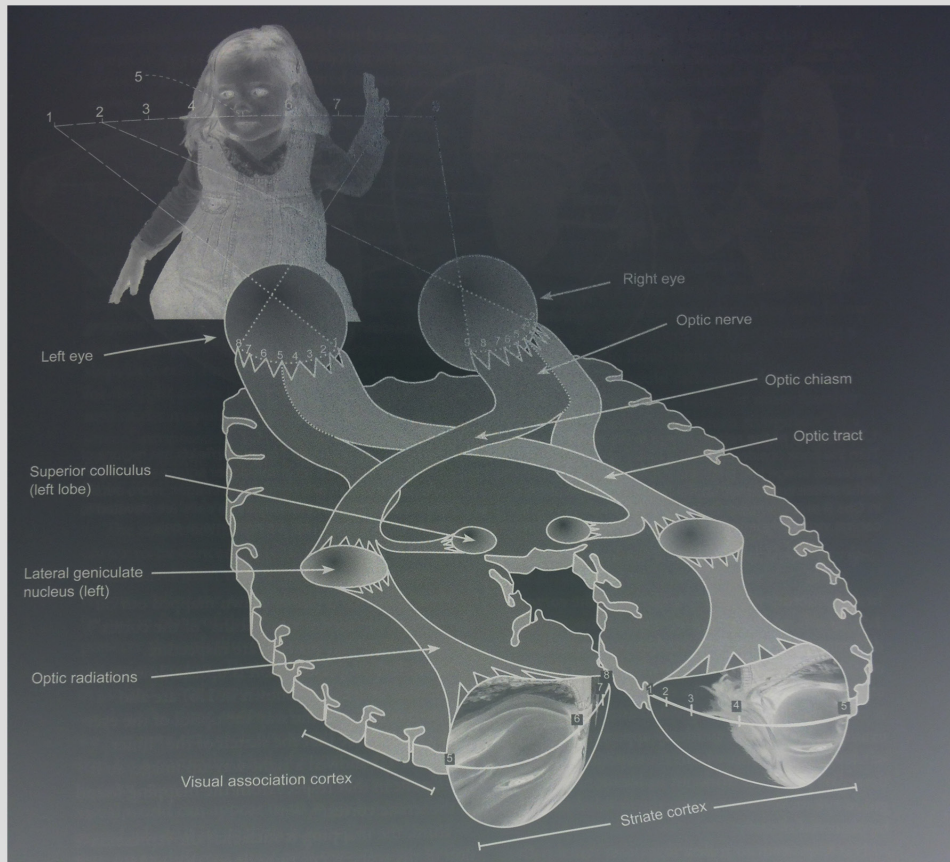
Common research

Relationship			How studied?
A.	Stimulus	→ Perception	Psychophysically. Present a stimulus and determine the person's response.
B.	Stimulus	→ Physiology	Physiologically. Present a stimulus and measure the electrical response in the nervous system; also look for connections between anatomy and perception.
C.	Physiology	→ Perception	Physiologically and psychophysically. Measure physiological and perceptual responses to the same stimuli.

perceptual cycle

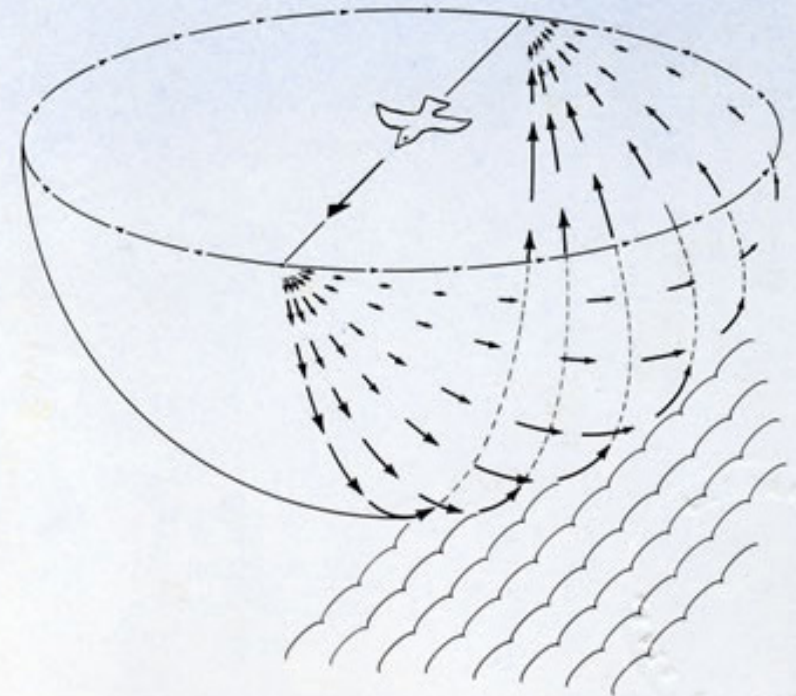


Keplerian layout - ecological approach

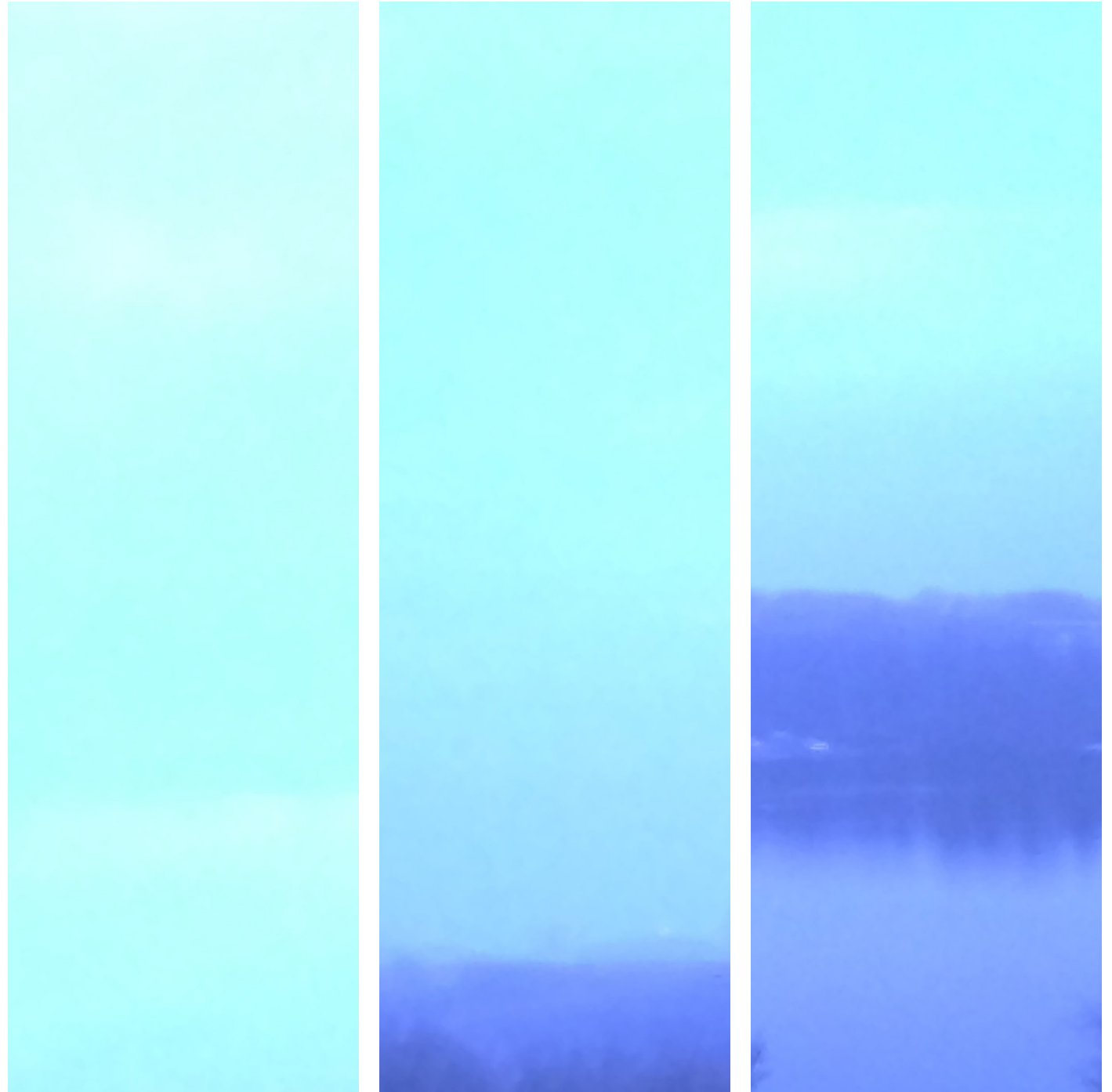


THE ECOLOGICAL APPROACH TO VISUAL PERCEPTION

James J. Gibson



sensory stimulation
sensory information



perception cannot occur with sole
stimulation

gradation of sensory information

complexity

contrast

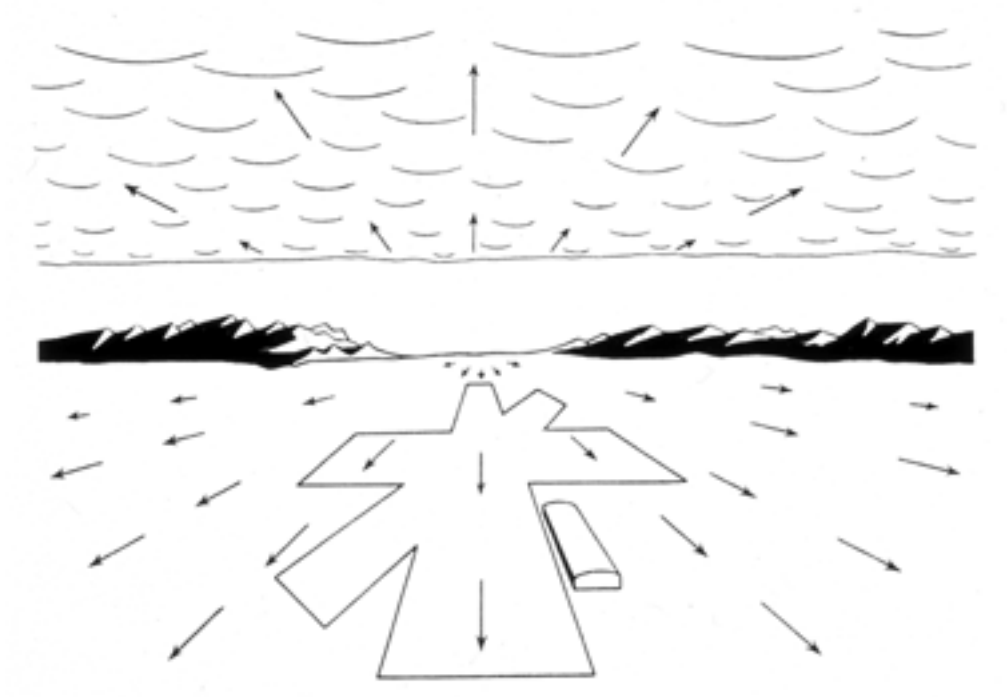
order

texture



optic flow

in theory



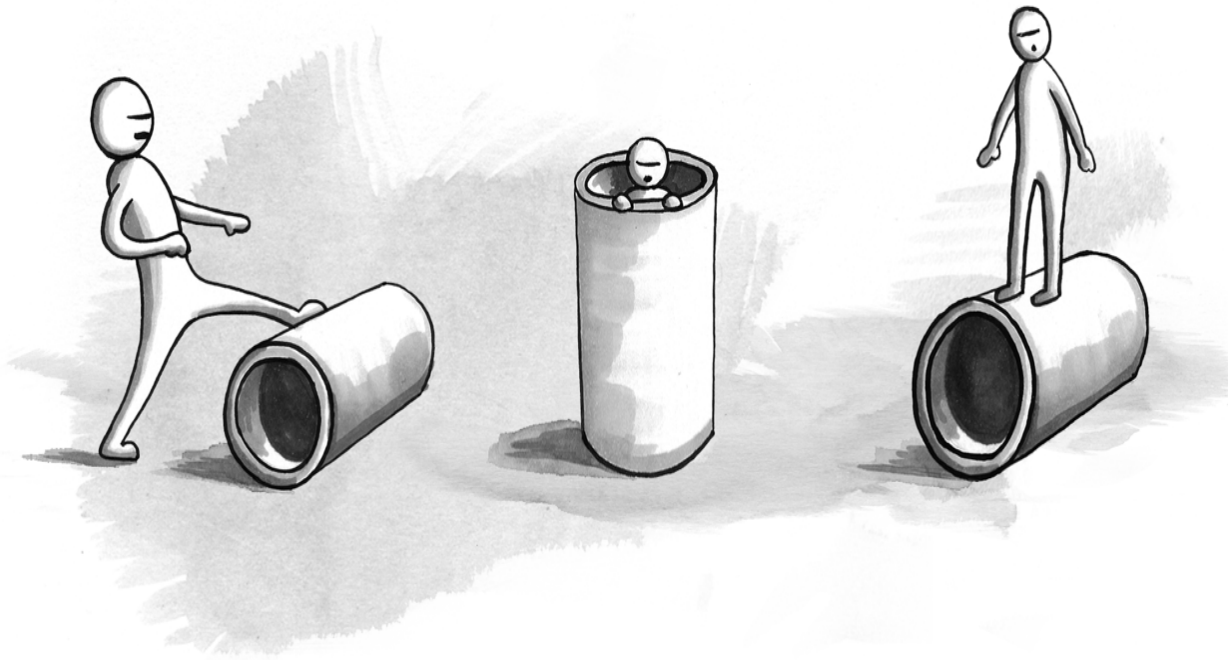
Gibson (1979)

in robotics/ computer/ AI vision



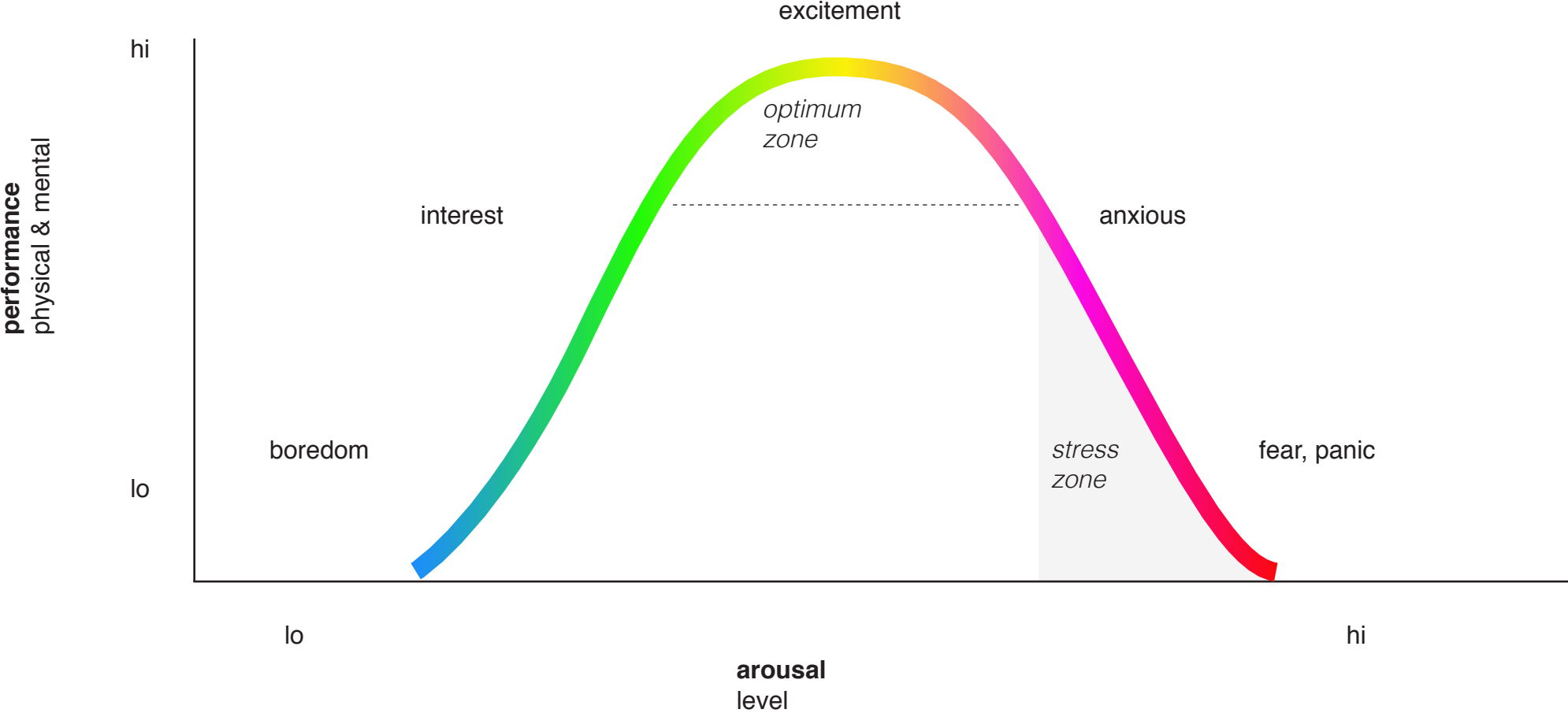
Sundaram, Brox, Keutzer (2010)

affordances



surfaces that “afford” information in relation to behaviour; it is up to us how we perceive it

arousal



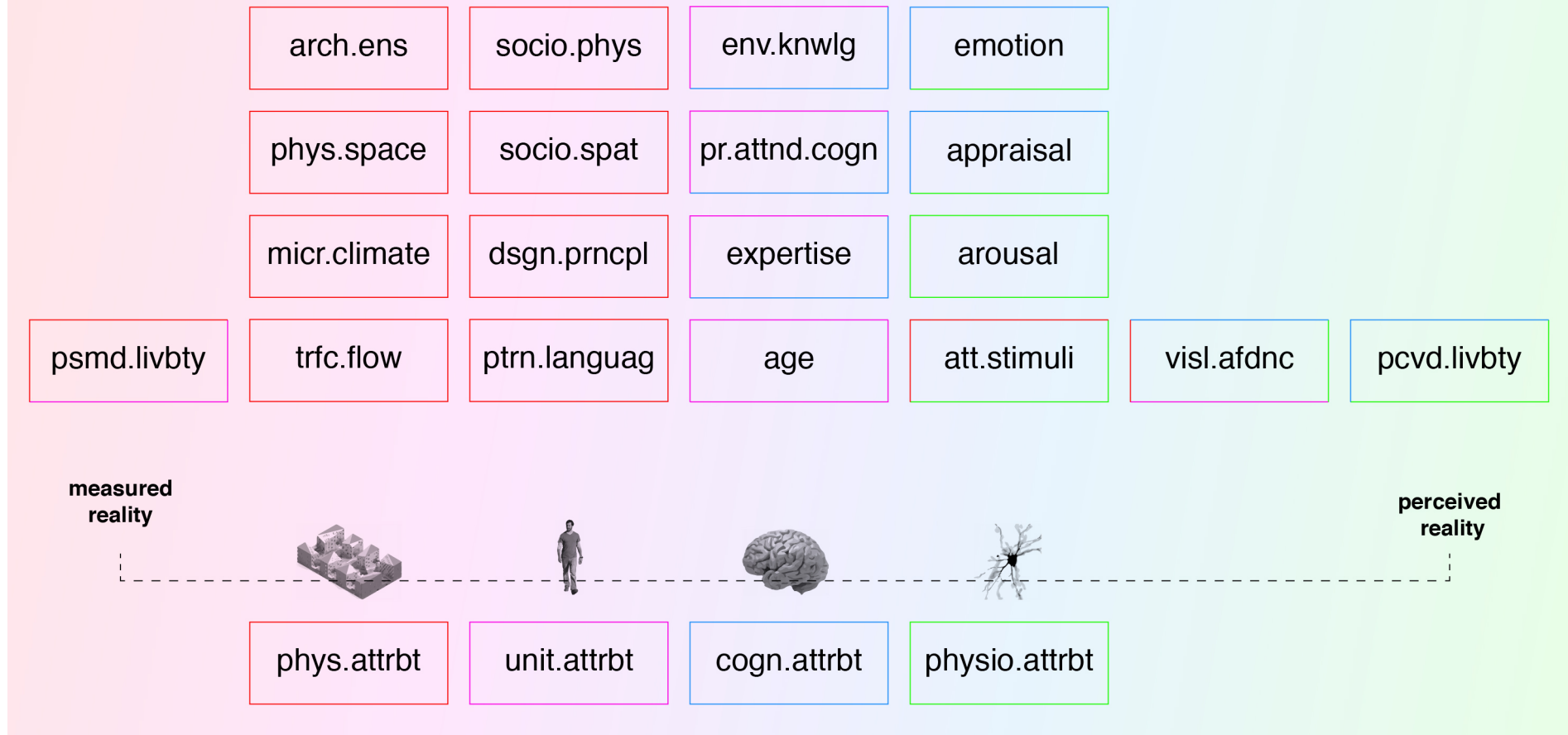
methodology

How to approach this?

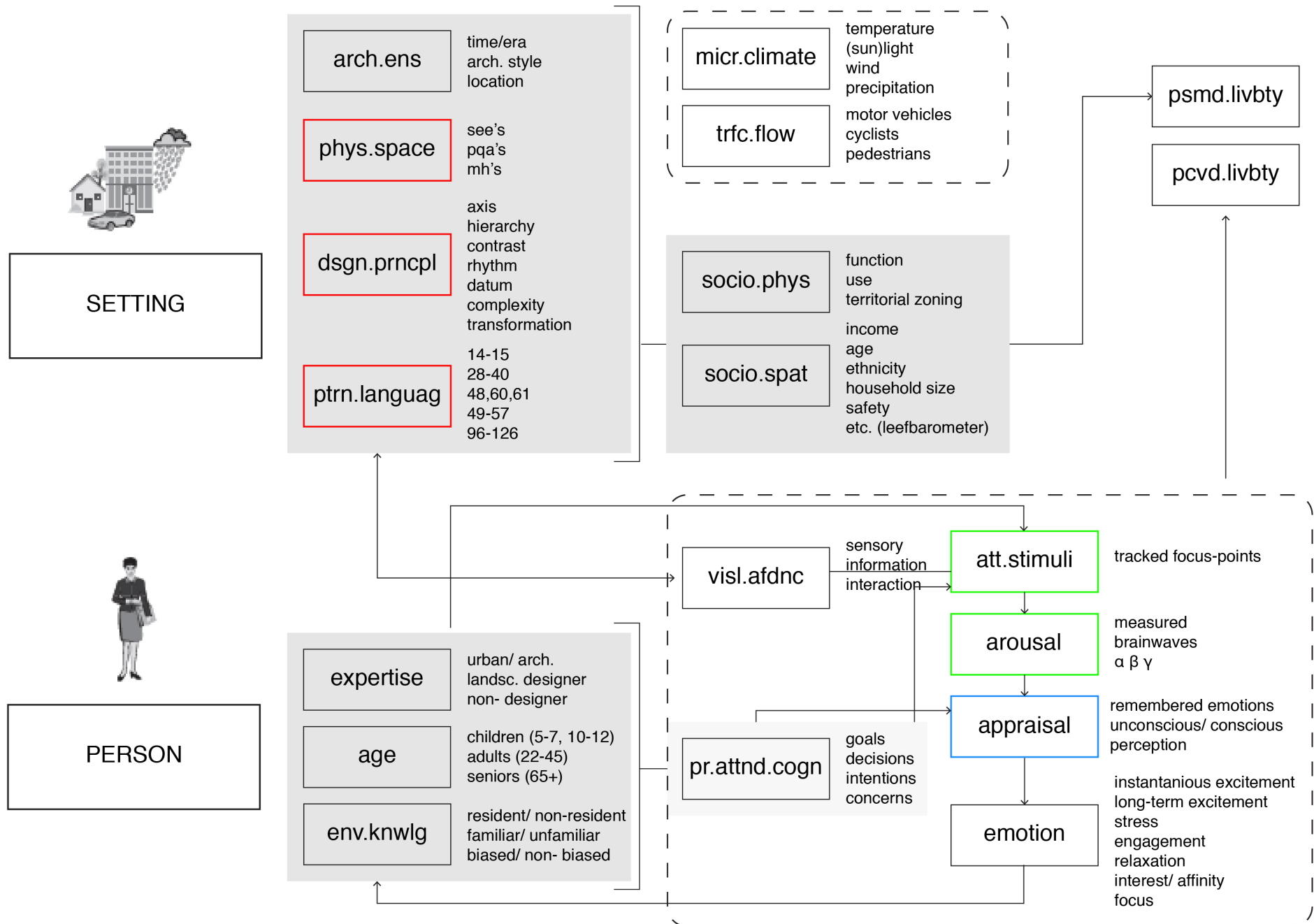
hypothetical variables

derived from arch. urb. design - env. psychology - & perception theory

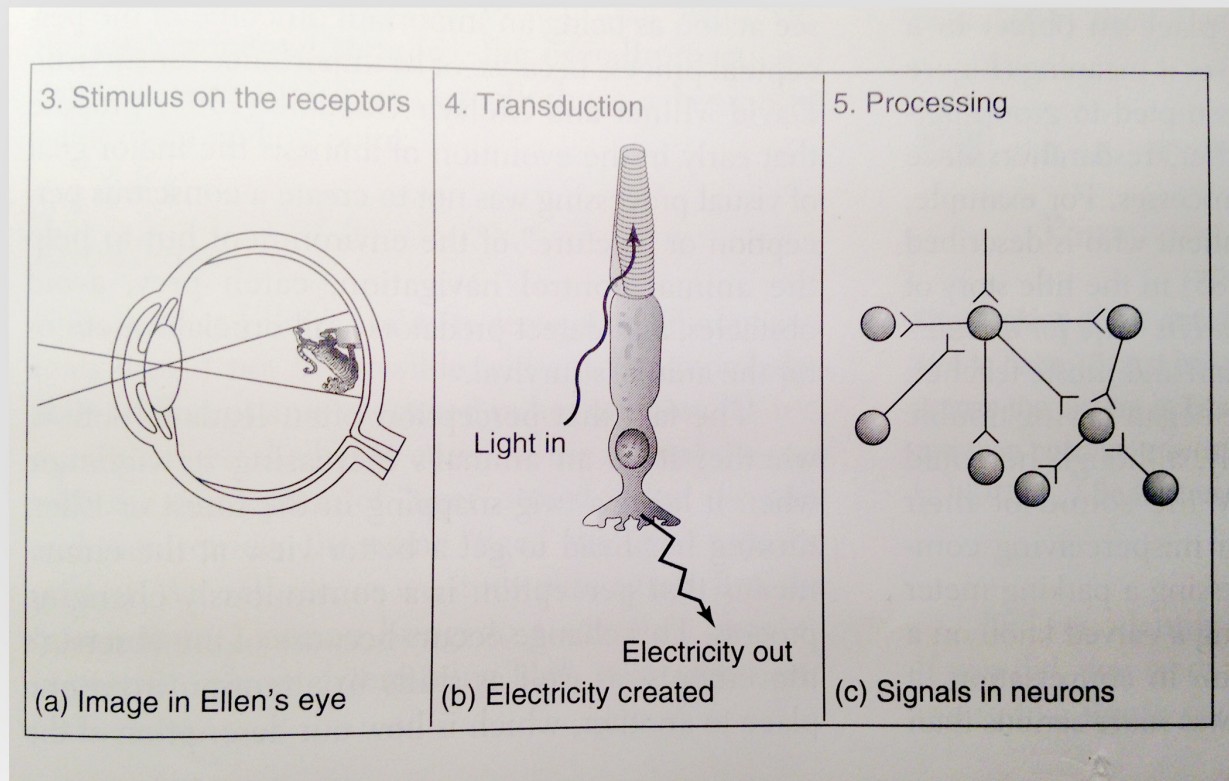
VARIABLE SPECTRUM



variables & relations in the basic env. psychology model



so... how to measure perception?



Frontal lobe

olfactory area
smelling

concentration
planning
judgement
emotional expression
creativity
inhibition

Cerebral cortex

muscles of speech
(Broca's area)

motor function
eye movement
orientation

Temporal lobe

written & spoken
language comprehension (Wernicke's area)

auditory area
hearing

association
short-term memory
equilibrium
emotion

Parietal lobe

motor function area
initiation of voluntary muscles

somatosensory association
evaluation of weight, texture, temp. etc. for object recognition

Occipital lobe

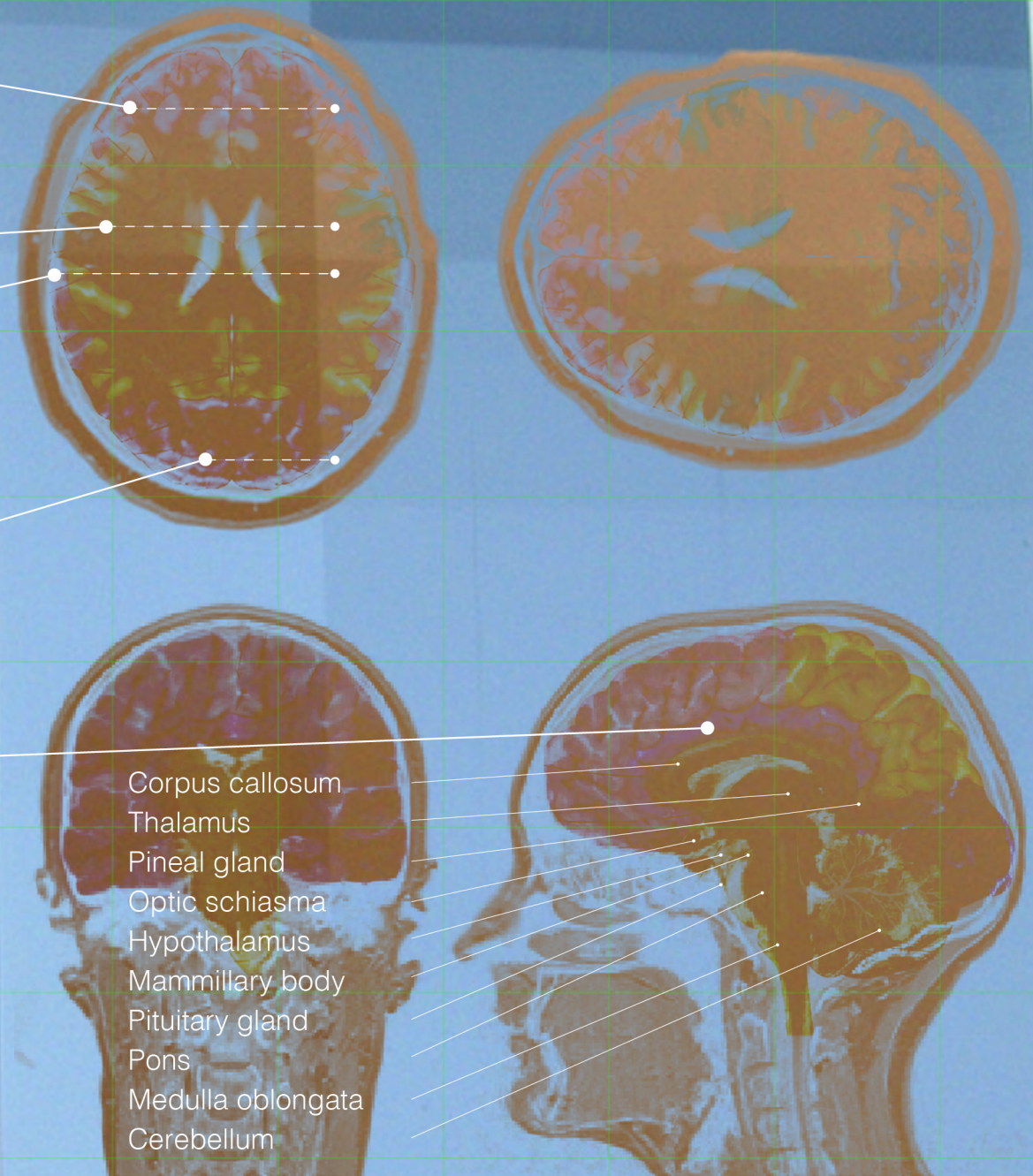
sensory association
sensations from muscle & skin

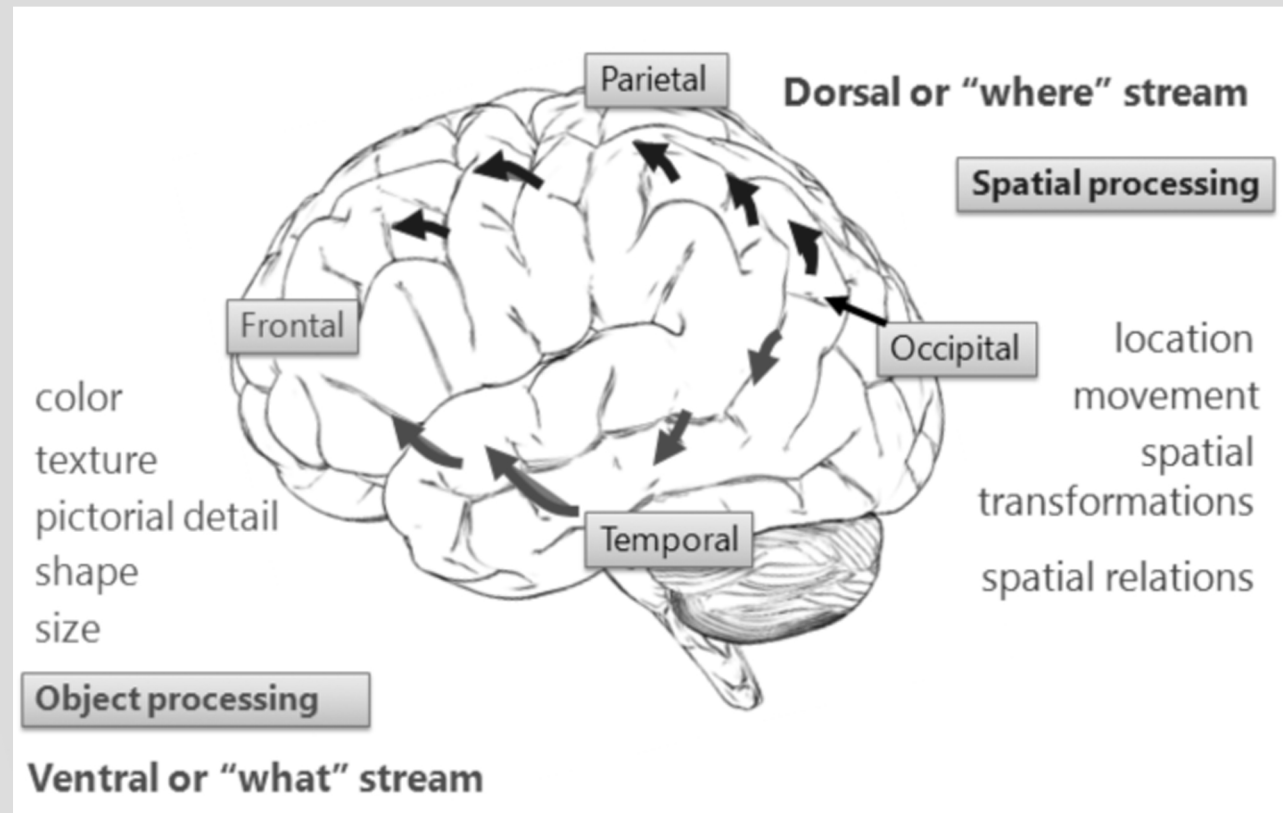
Lymbic lobe

sight
image recognition
image perception

pain
hunger
fight or flight response

basic anatomy of the human Brain





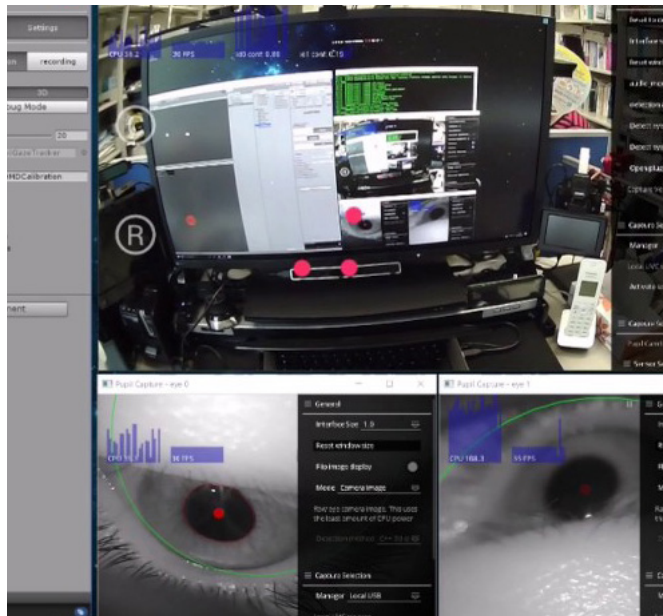
equipment



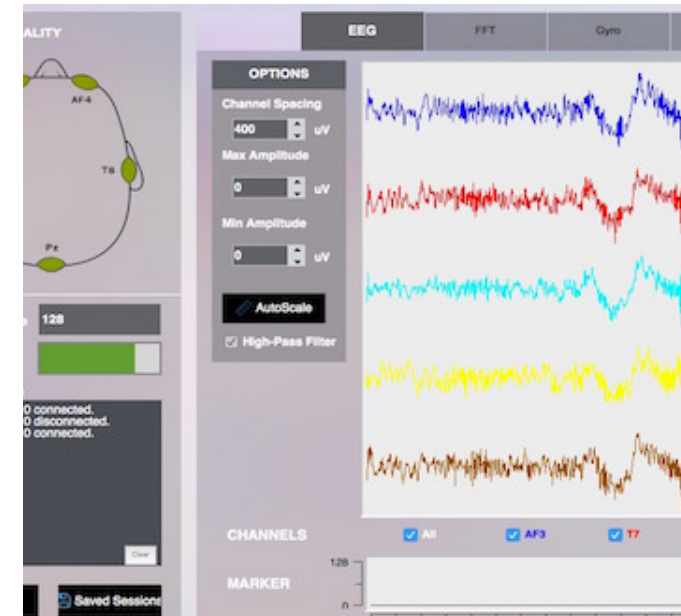
Pupil-Labs® mobile eye-tracker



*Emotiv Insight® 5 Channel
Wireless EEG Headset*



*Pupil-Labs Capture software
interface*



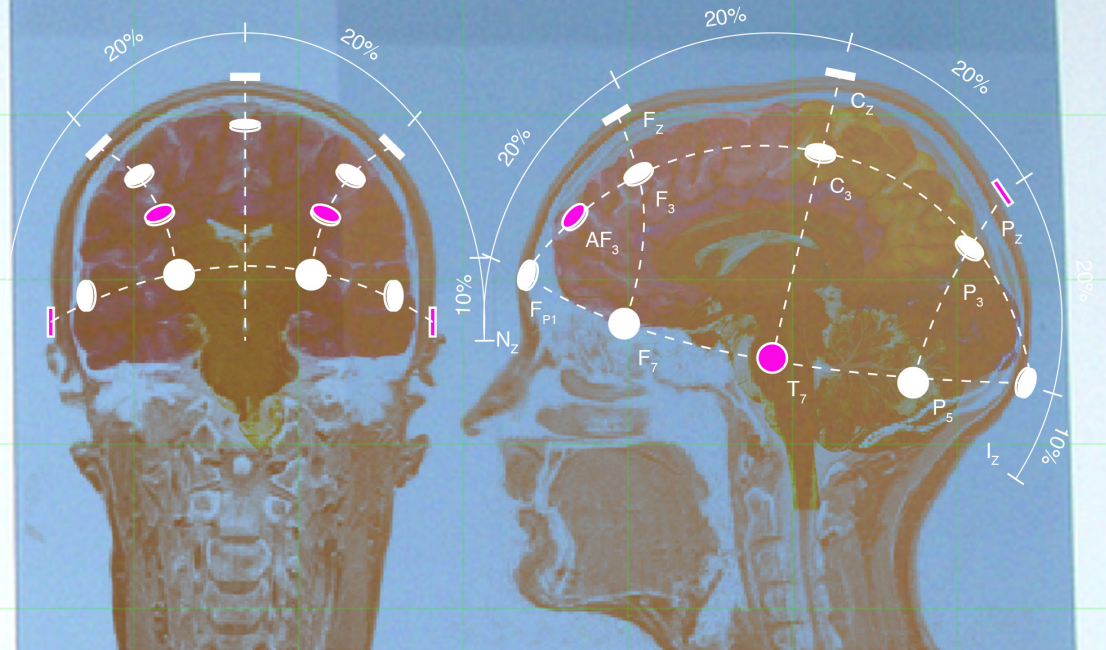
*Emotiv Pure EEG software
interface*

EMOTIV insight



understanding electro- encephalography

EMOTIV insight



brain waves

α β γ θ δ

Gamma: higher processing tasks & cognitive functioning

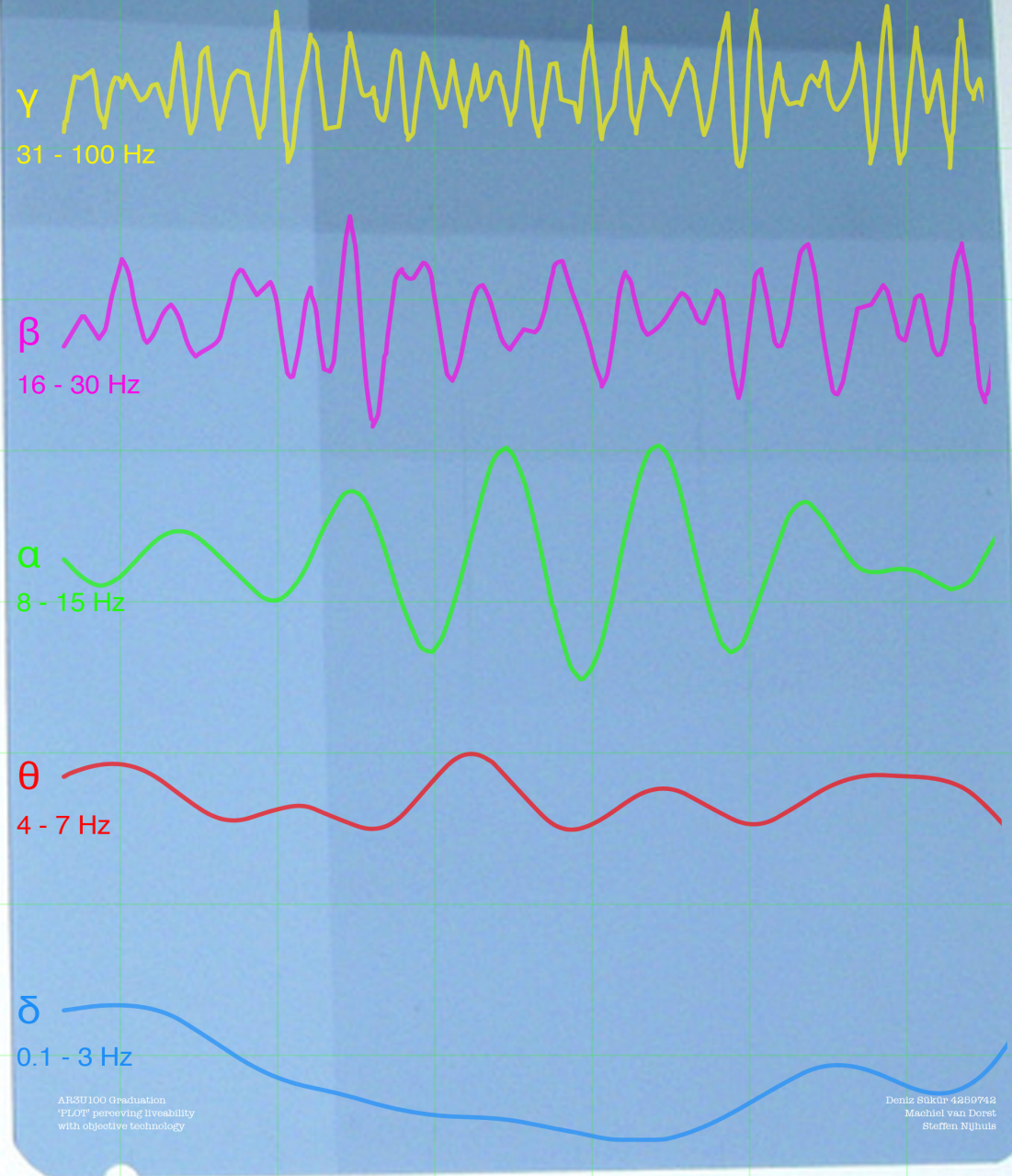
Beta: normal waking consciousness & heightened state of alertness

Alpha: quietly flowing thoughts, daydream or light meditation

Theta: in a dream, vivid imagery, intuition and information beyond normal consciousness

Delta: deep dreamless sleep & in deep transcendental meditation

understanding electro- encephalography



Which **spatial elements** are essential in influencing our visual **perception of urban environments**, and how can we explicate and express these elements in **urban design**?

Can we find patterns of gaze behaviour, change in EEG freq. bands, and gazed elements?

What specific attributes do they have in common?

How can we express these attributes in urban design?

spatial analysis

First of all, let's define the urban environment

two cases

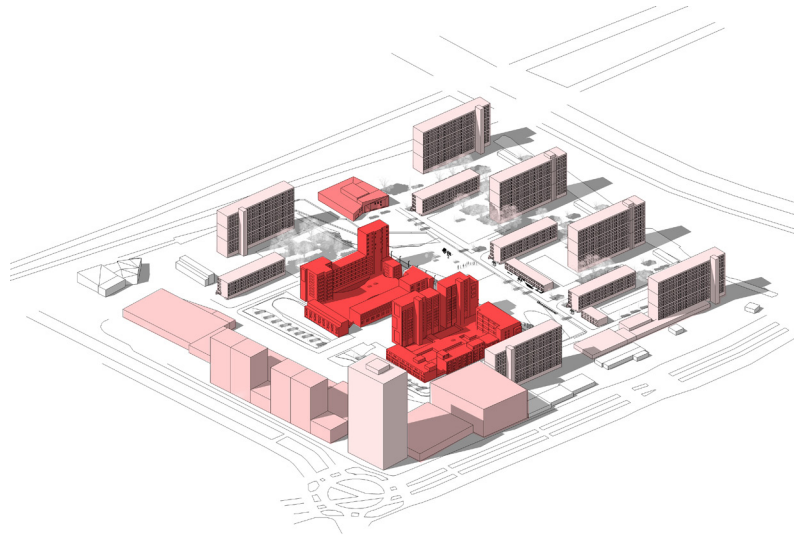


*Poptahof & Westerkwartier in
Delft (google, edited)*

with a different pattern language

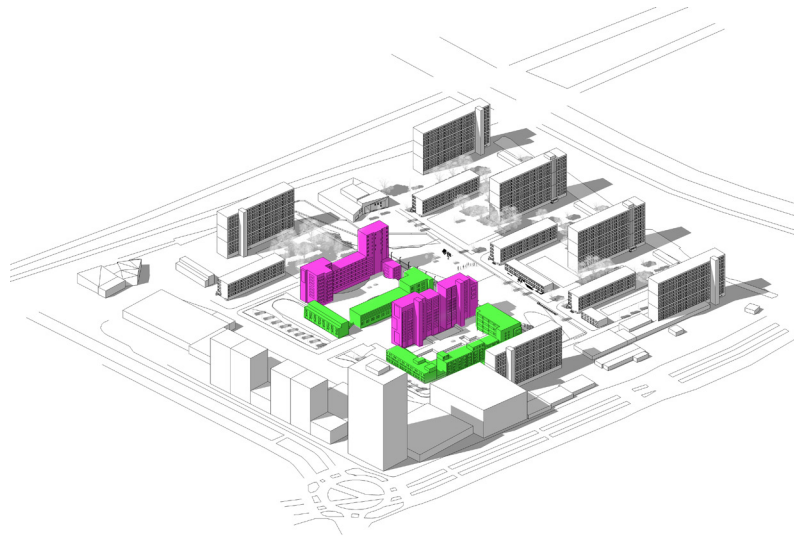
#95 Building complex

A building represents a manifestation of a social group or social institution and therefore should be, like the group or institution itself, devised into visible smaller entities to make it more interactive with humans. The image shows buildings and their rate of identifiable parts.



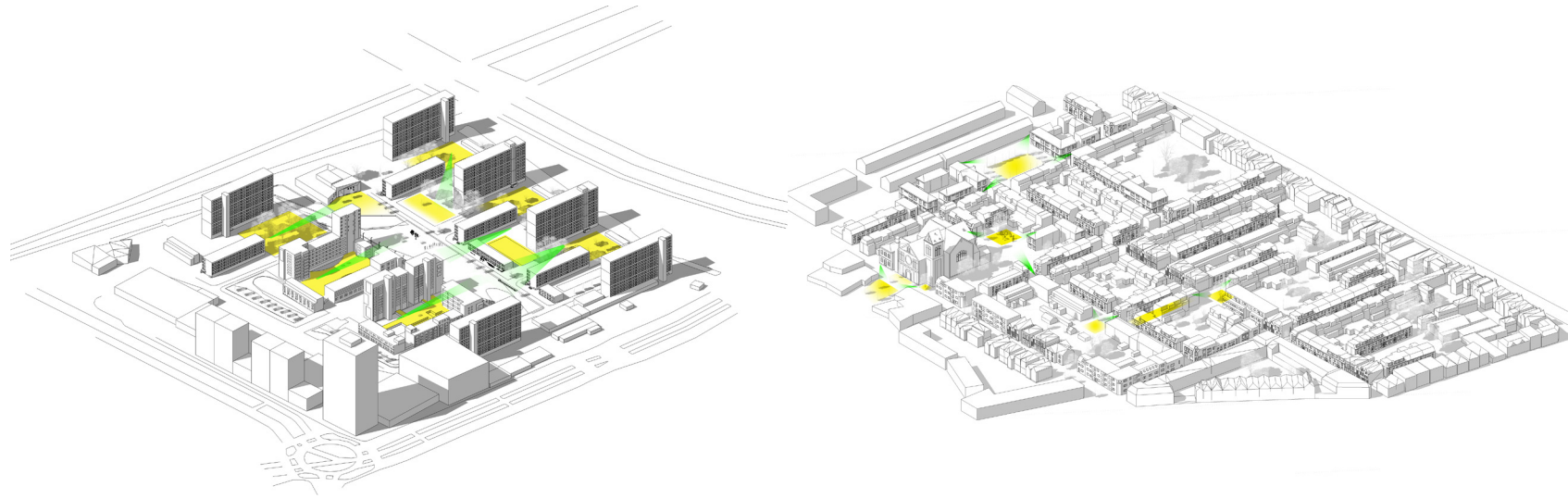
#108 Connected buildings

Isolated buildings are symptoms of a disconnected society. Referring to psycho-social disintegration at the emotional level, a town with disconnected buildings would depict a society made up with disconnected and isolated selves.



#114 Hierarchy of open spaces

People always try to find a spot with their backs protected and with a view to a larger opening, beyond the immediate space in front of them. It is therefore essential to create smaller spaces that form a natural back, with openings and views towards at least one larger space.



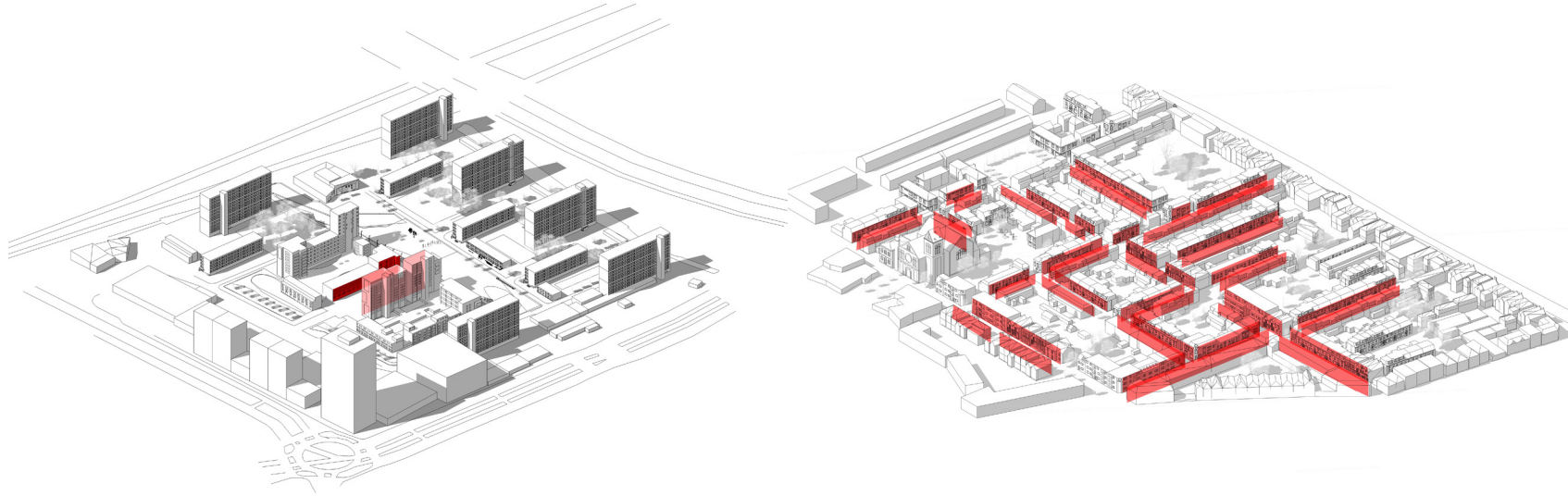
#120 Paths and goals

The process of walking is crucial for the layout of paths. As we walk, we scan the landscape for intermediate destinations and try to walk in a straight line towards these. We arrange our walking paths in a way that we pick a temporary goal – a clearly visible landmark – which is more or less in the same direction. As we get closer, we pick another goal so in the meantime we can think or daydream, without thinking about our walking direction every minute. If there aren't enough intermediate goals, the process of walking consumes unnecessary emotional energy.

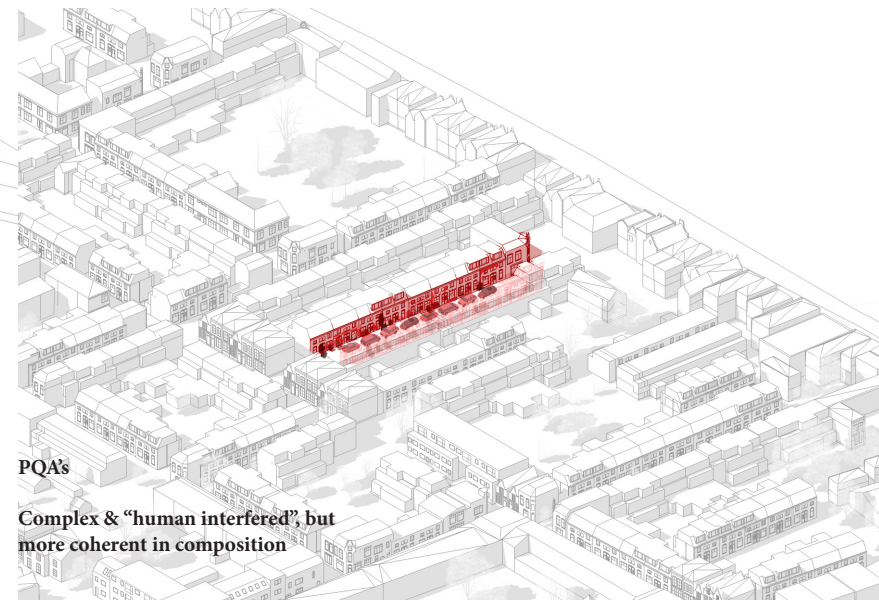
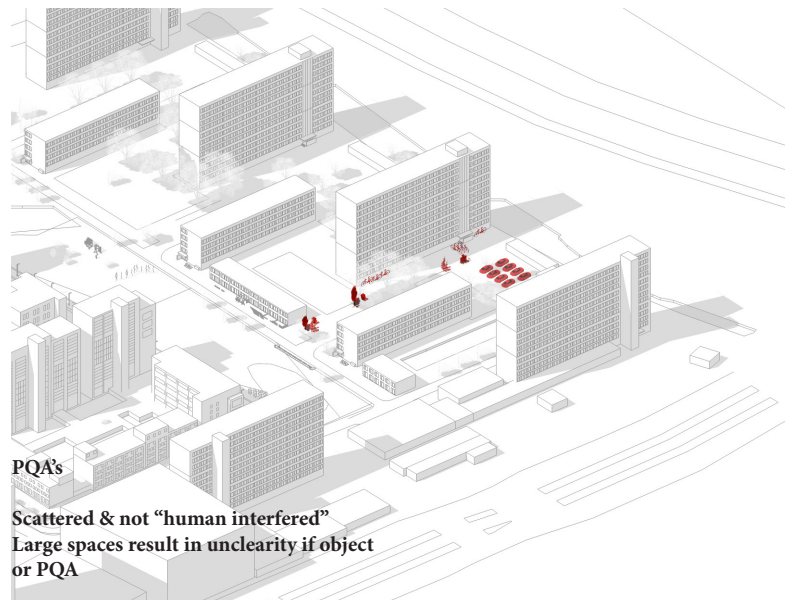
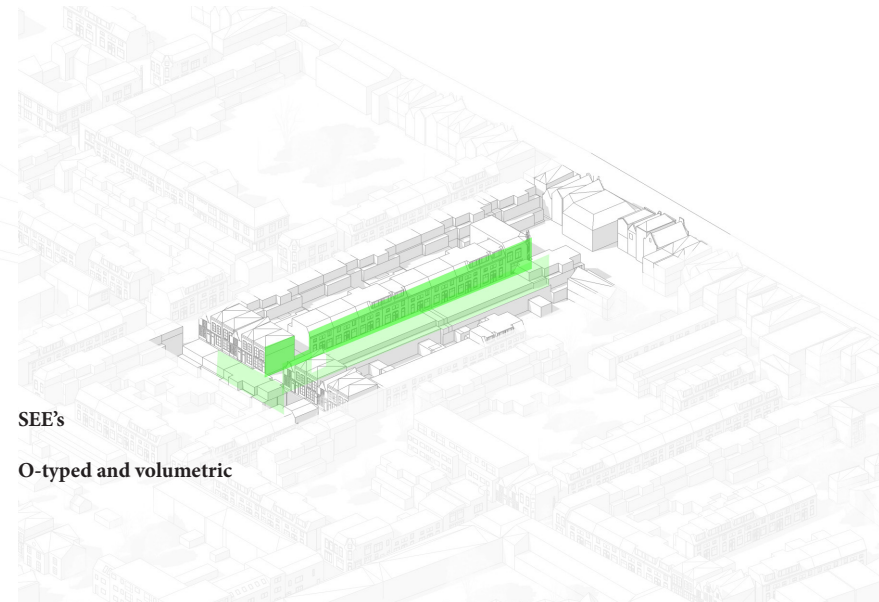
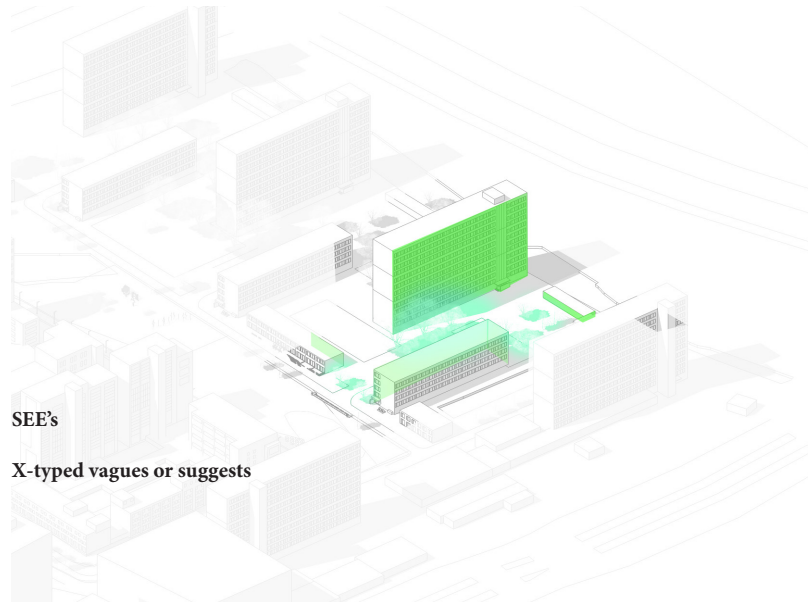


#122 Building fronts

Building set-backs from the late 20th century where aimed at creating more light and air, while they also destroyed the street as a social space. It is essential to create building fronts with the mindset that they also create streets and spaces in front of them. On no account should there be set-backs. Buildings should face the street directly, preferably with a slightly uneven angles emphasize the shape of the street.



and different SEE's - PQA's

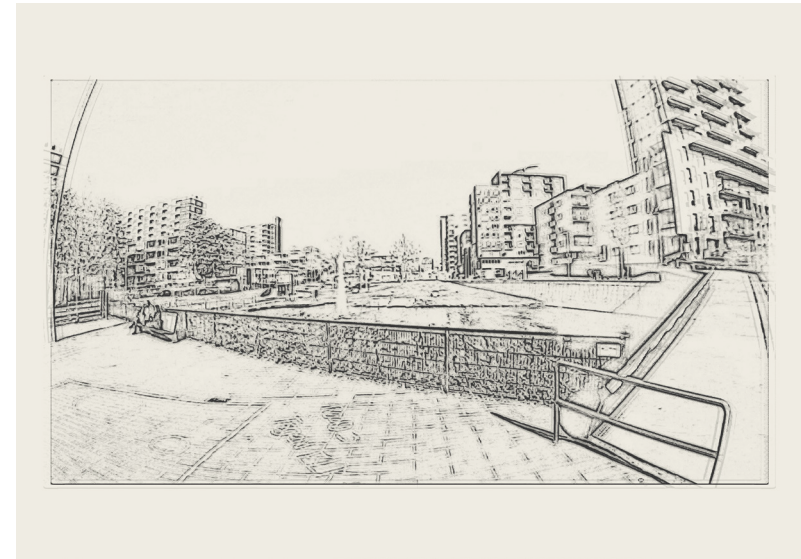


scenes



Westerkwartier

- spatially more coherent, with very complex and personalized objects
- humanly interfered PQA's along the façades
- vistas with a clear vanishing point are present
- elements such as window frames, doors or rain pipes create rhythmic patterns, while corners of buildings, slim trees, blind façades, overhangs or dormers create certain datum



Poptahof

- generally defined by X-shaped spaces with vagues
- impossible to create internal representations of space within these kinds of scenes (Prak,1969)
- spaces lack foreclosure and create dispersed and messy visual arrays
- the sequence with a clear view of the park creates a *serial view*, which emphasizes the SEE surface on the UNDER-side, ultimately creating a more coherent picture

data analysis

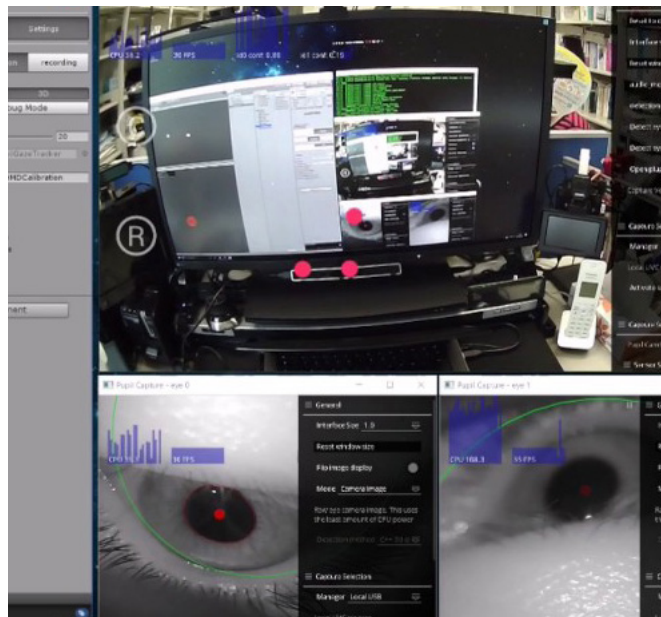
equipment



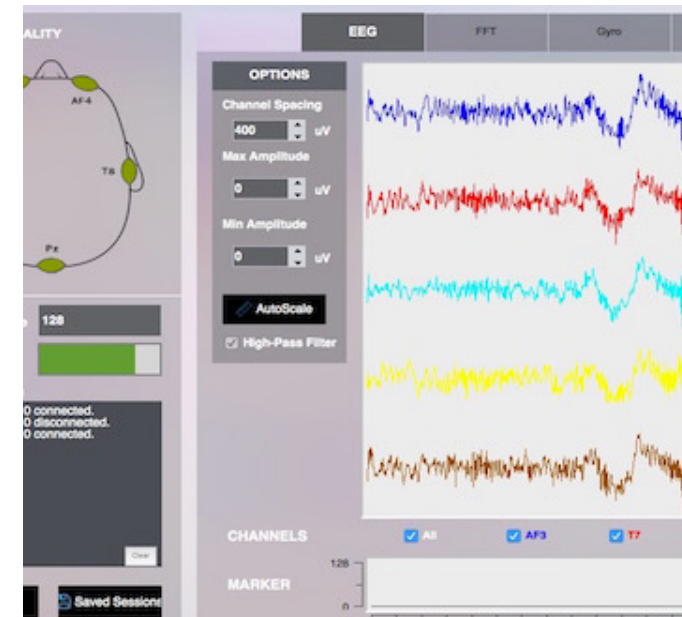
Pupil-Labs® mobile eye-tracker



*Emotiv Insight® 5 Channel
Wireless EEG Headset*

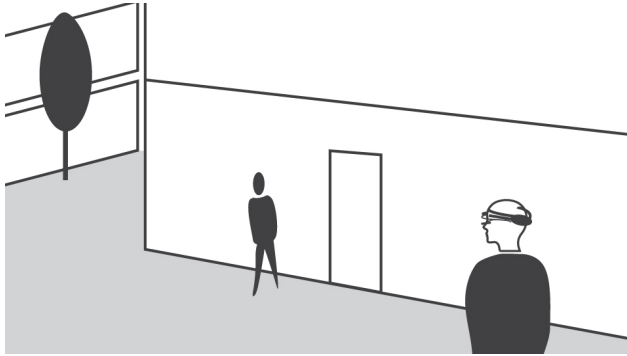


*Pupil-Labs Capture software
interface*



*Emotiv Pure EEG software
interface*

Method 1: Field runs



Direct sunlight & overexposure

Rain and wind

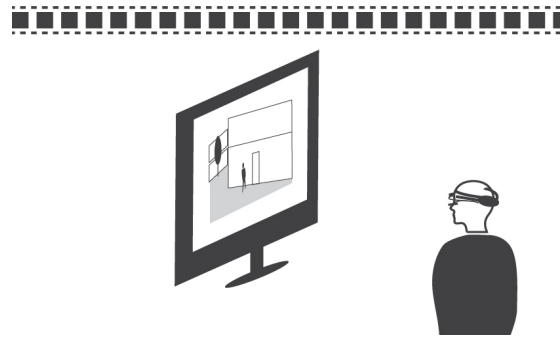
Head motion and FOV influence

Hardware specifications

Retinal image stabilization

Locomotion, scanning, and motor function

Method 2: Video tracking



Scanning surfaces and objects

Vestibulo-ocular reflex

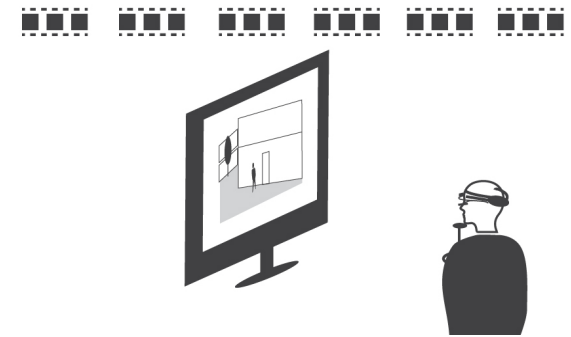
Frame-freeze

EEG dynamics

Comparing validity

Fake encounters

Method 3: Randomized scenes with chin rest



Pre-attended cognition

Validation by comparison

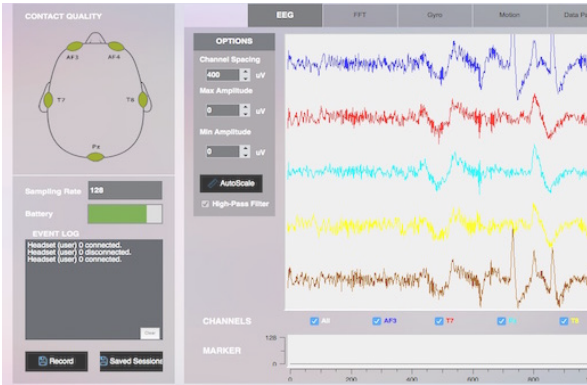
Shaky video stabilization

More comfortable

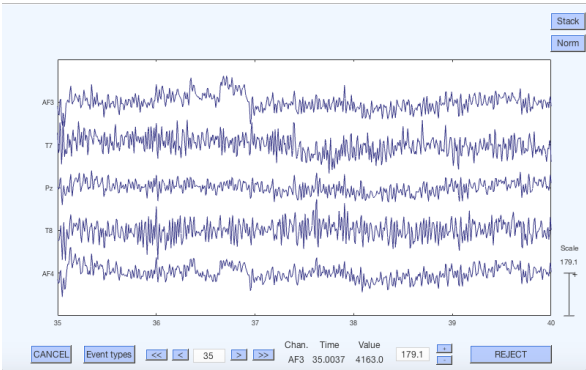
data analysis methods & tools



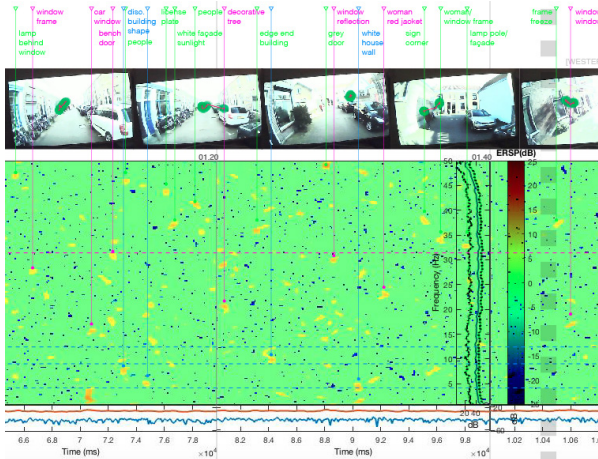
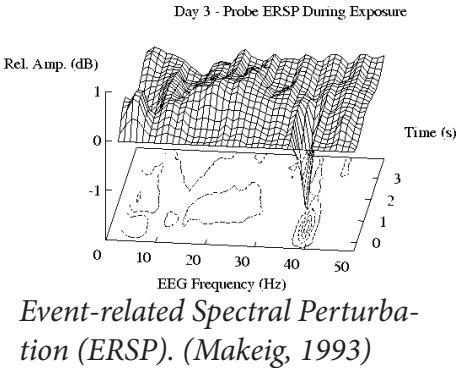
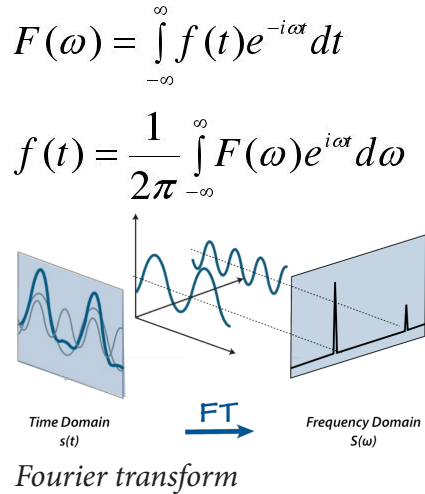
Eye-tracking video of Westerkwartier

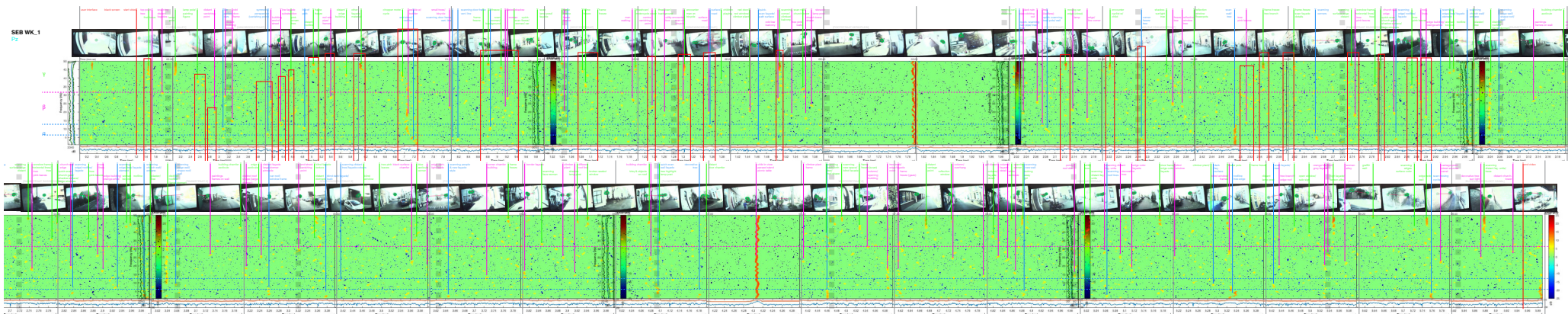
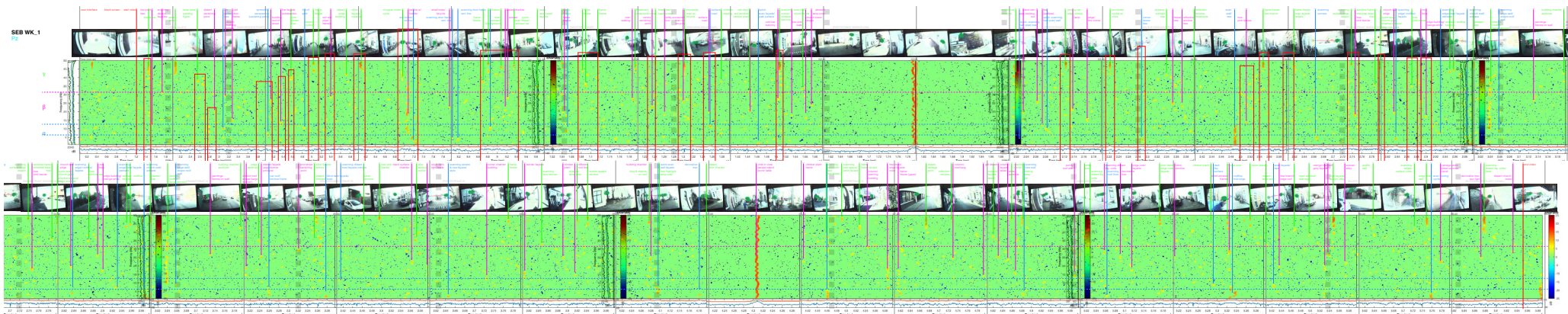
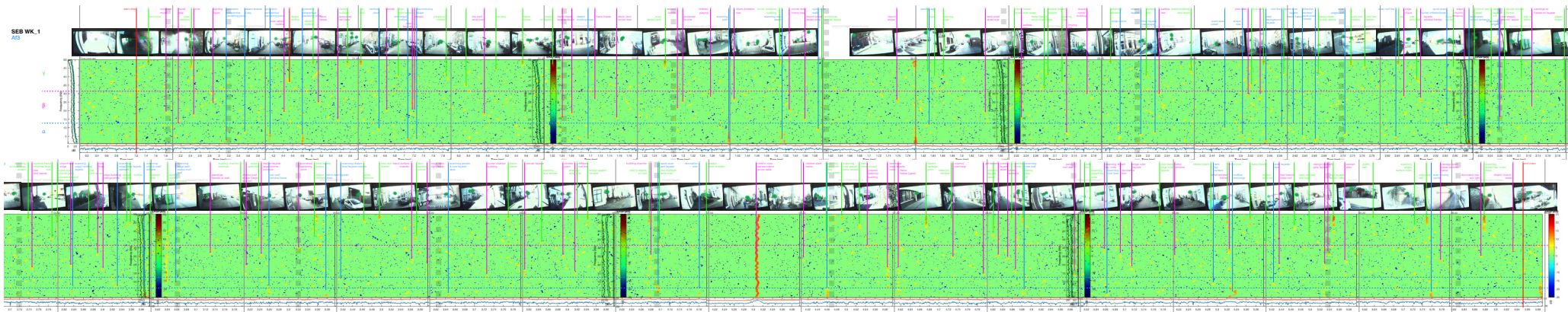


EMOTIV 'Xavier pure EEG' interface

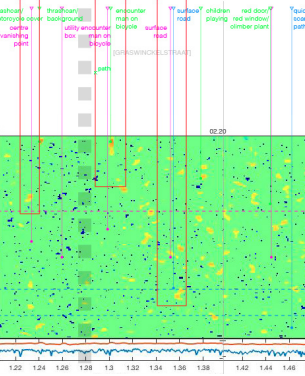


EEG Lab's scroll function

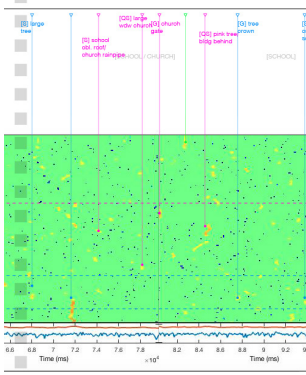
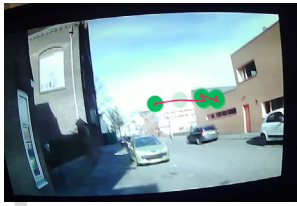




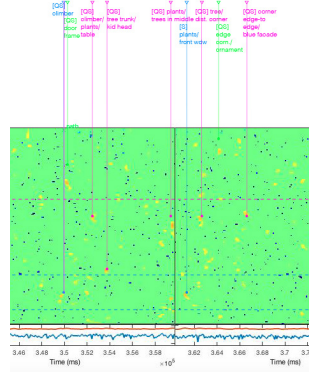
examples westerkwartier



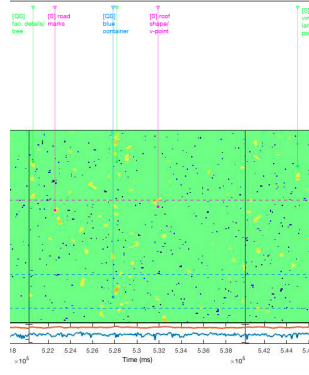
S1 - Encounter with cyclist



S2 - Oblique school roof

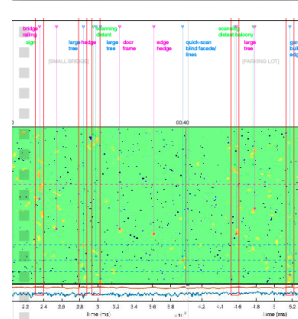


S5 - Large tree trunks

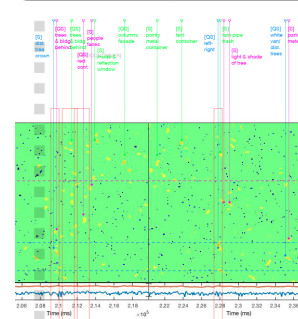


S7 - Vanishing point & roofline

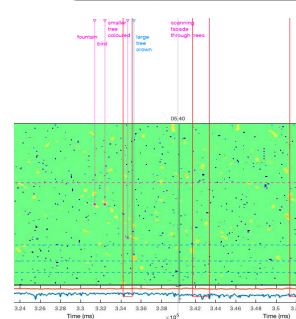
examples poptahof



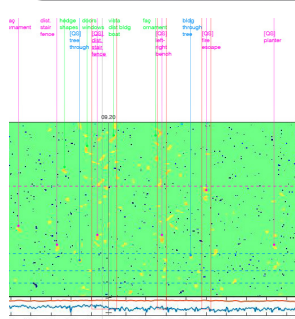
S1- Scanning tree, bridge railings, path



S3- Red container & people in front of them



S3- Smaller coloured tree & large tree w/ big green crown



S7 - Ornaments inside courtyard

results

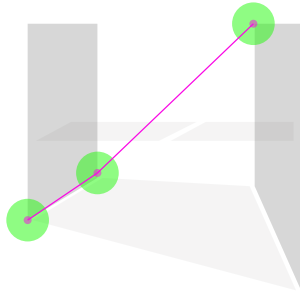
q 1:

Can we find patterns of gaze behaviour, change in EEG freq. bands, and gazed elements?

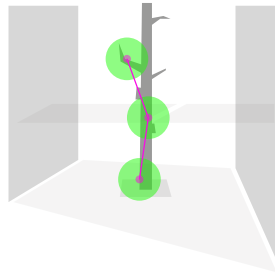
gaze

GAZE BEHAVIOUR

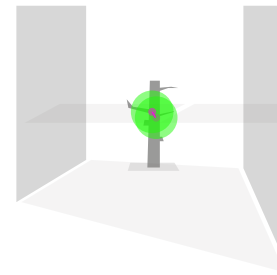
QUICK-SCANS



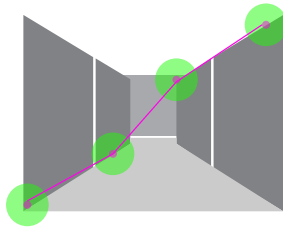
CONSISTENT SCANS



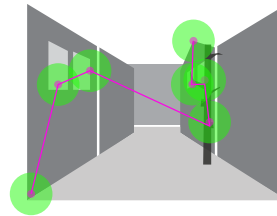
GAZE



bldg. edges / v-points / path /
rooftlines / left-right



grouped detailed surfaces /
objects adjacent / objects behind
each other / chamfered corners /
diversiform shapes

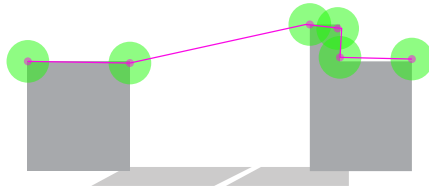


people / distant objects /
signs

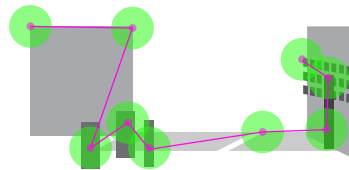


ENCLOSED SPACES (suggests & o-type volumes)

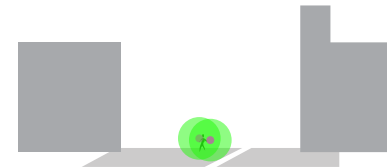
dist. bldg. shapes / paths / large tree-
crowns / scattered (vert. objects)



grouped objects / objects-surfaces
behind each other / moving objects



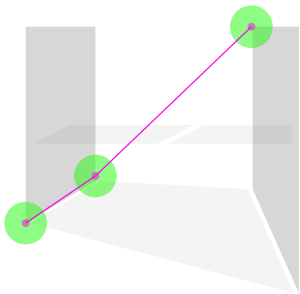
people / distant objects /
signs



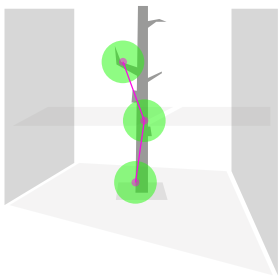
OPEN SPACES (x/o-type vagues)

GAZE BEHAVIOUR

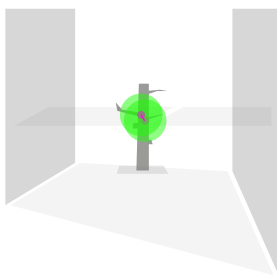
QUICK-SCANS



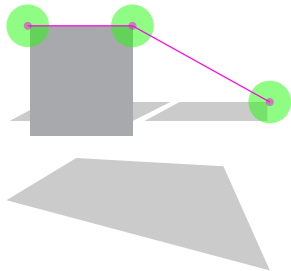
CONSISTENT SCANS



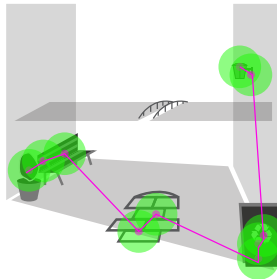
GAZE



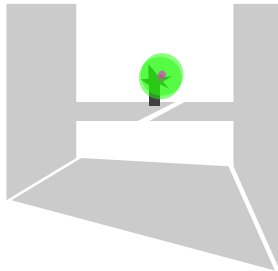
LOW INFO



HIGH INFO

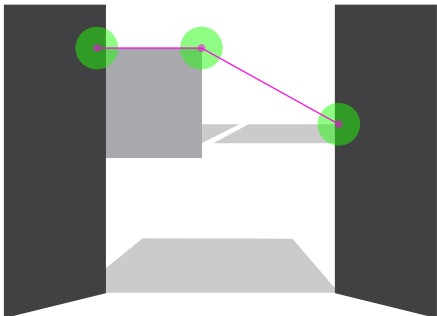


UNCLEAR

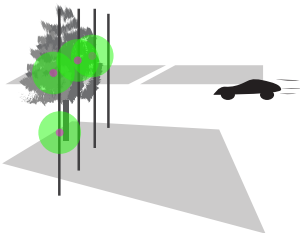


OBJ/ SURFACE
information

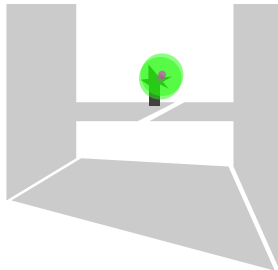
rapid disruptions / fast moving obj



object-screen
relative motion / moving obj



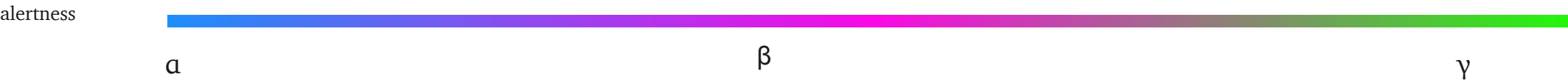
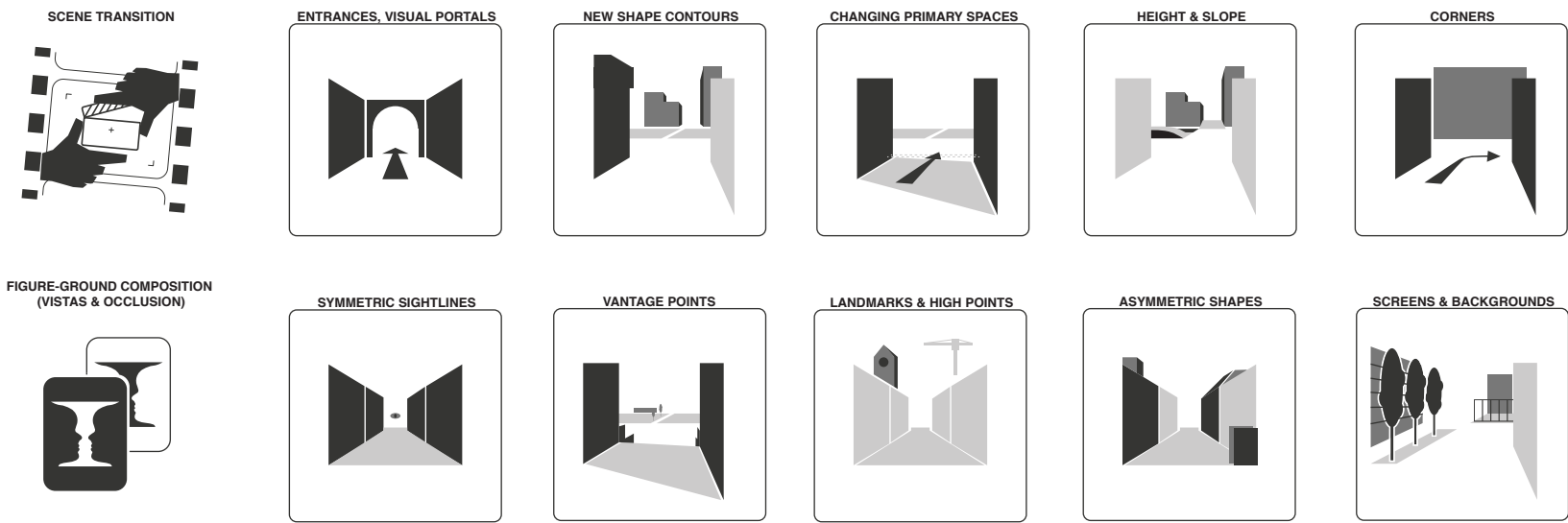
no/ low motion



OBJ/ SURFACE
motion

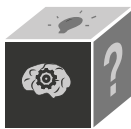
eeg frequency - SEE

SPACE ESTABLISHING ELEMENTS (SEE's)

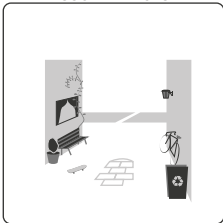


eeg frequency - PQA

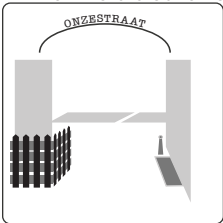
OBJECT (RE)COGNITION



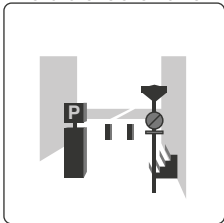
SOCIAL TRACES



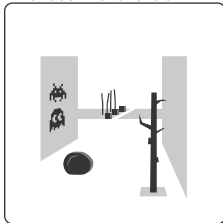
TERRITORIAL OBJECTS & ZONES



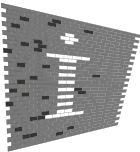
OBJECTS AS OBSTACLES



UNUSUAL OBJECTS & ART



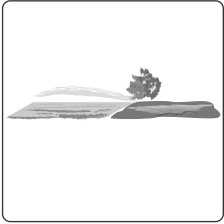
SURFACE INFORMATION / OBSERVATION



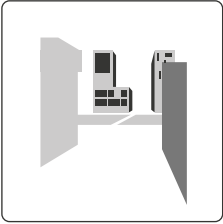
PATHS & ZONES



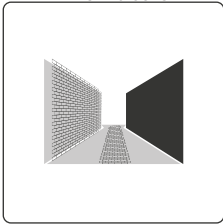
NATURAL SURFACES



ODD & UNUSUAL SURFACES



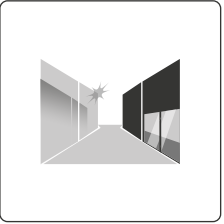
TEXTURE & COLOR



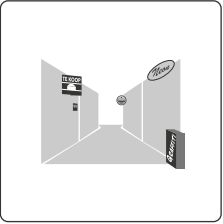
DYNAMIC FAÇADE UNITS



TRANSPARENT & REFLECTIVE SURFACES



SIGNS, NUMBERS & TEXT



alertness



α

β

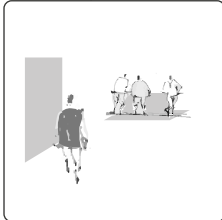
γ

eeg frequency - occasions

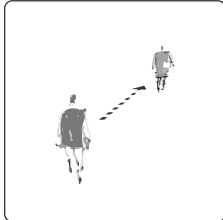
HUMAN ENCOUNTER SITUATION



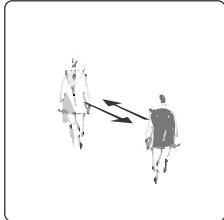
CHILDREN, ANIMALS & PETS



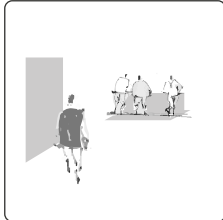
PRECAUTIONARY



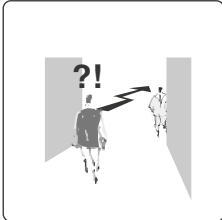
FACE-TO-FACE



GROUPS



SURPRISE



TRAFFIC ENCOUNTER SITUATION



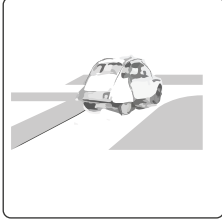
CROSSING



MOVING CYCLISTS



MOVING CARS



alertness



α

β

γ

q 2:

What specific attributes do these elements have in common?

complexity of sensory information:

information potency vs. information redundancy

visual deprivation vs. cognitive overload



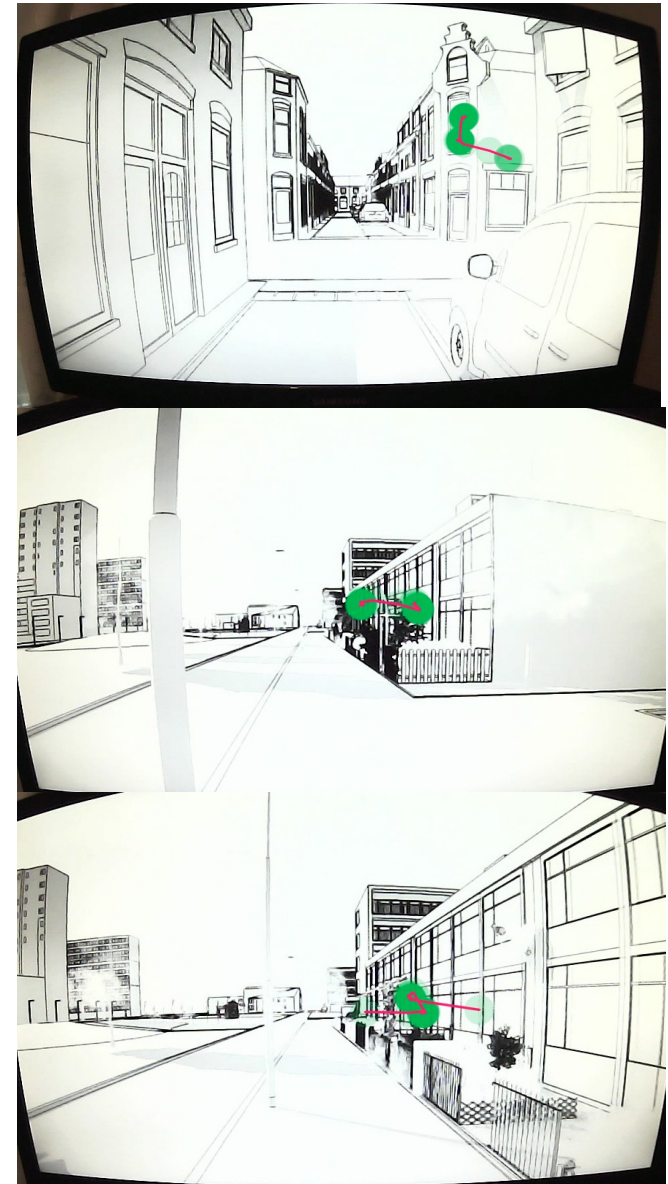
*Under-stimulation raises
orienting response... What is it?*



*Over-stimulation causes information redundancy.
You try to avoid collision.*



From low information to complex. What is it?



Complex information rather than volumes

**Architectural complexity:
Volume and details**

Complexity in visual sensory information on the level of a single building.

The complexity scale is rather relative to the building size and our distance from the building:

the larger the building, the more effort is needed to create complexity, and, the greater our distance from the building, the less information in detail can be perceived.

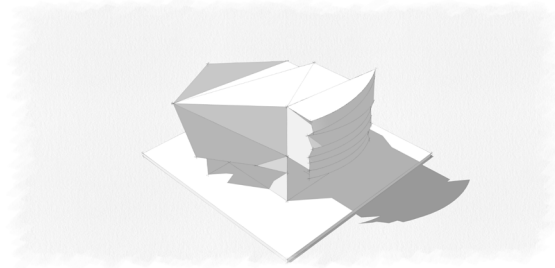
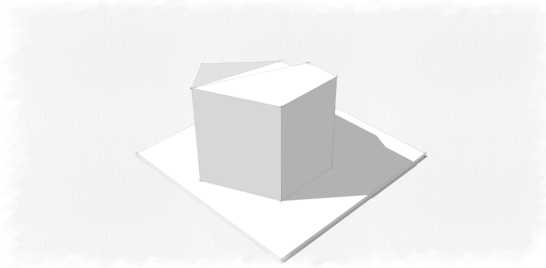
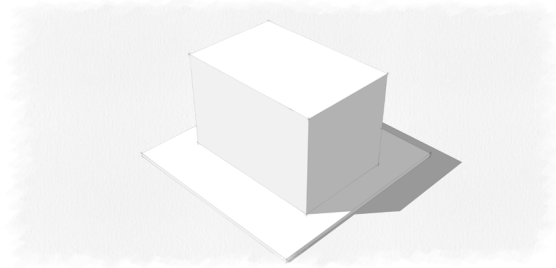
E.g. at a greater distance texture can become redundant, while articulation can replace its complexity-increasing function.

Too little = easy & quick perceived

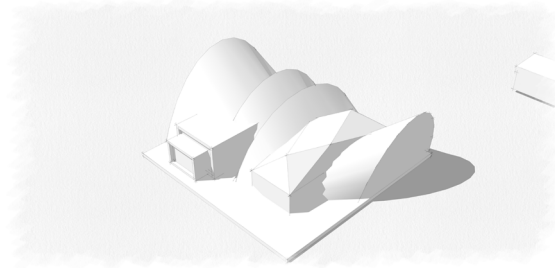
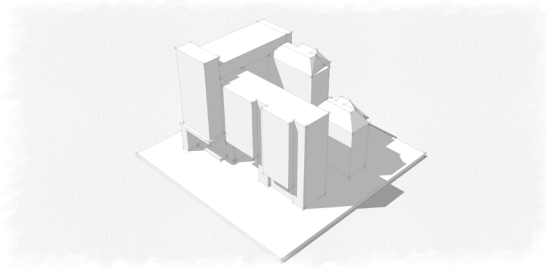
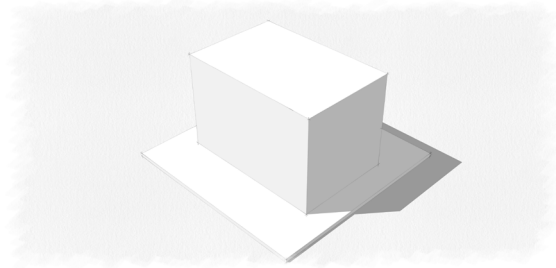
Too much = overwhelmed (sexy, postcard architecture)

Arch_volume

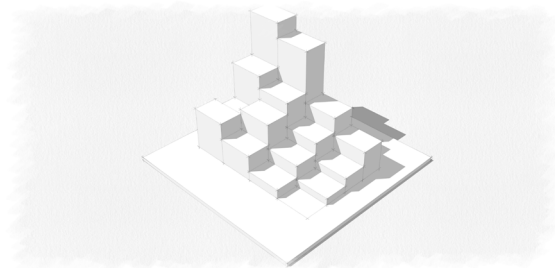
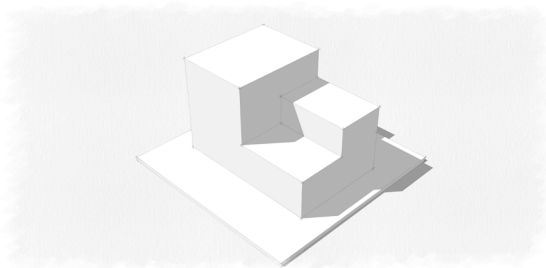
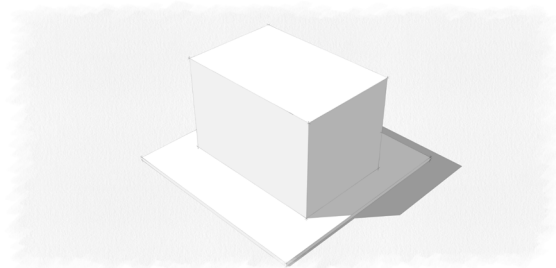
Plasticity: The extent of three-dimensional deviation of a prismatic building form.



Articulation: Three-dimensional division of the total building appearance into recognizable parts that retain a certain relation with each other.

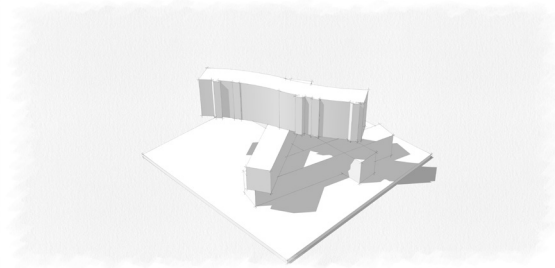
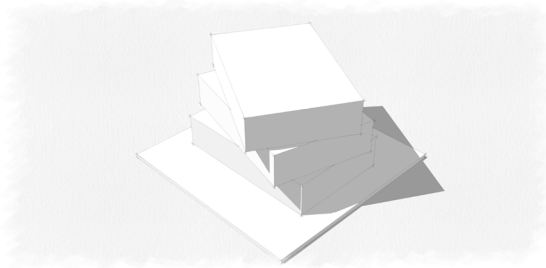
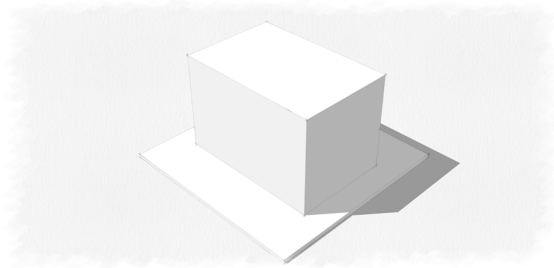


Height difference: Difference in building height that is expressed through the roofline.

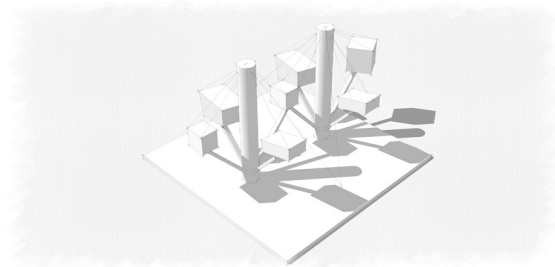
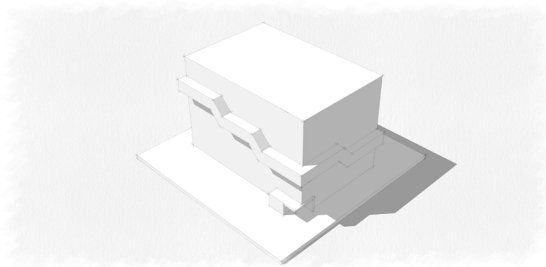
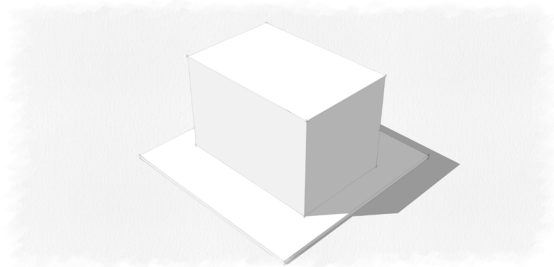


←—————→
complexity

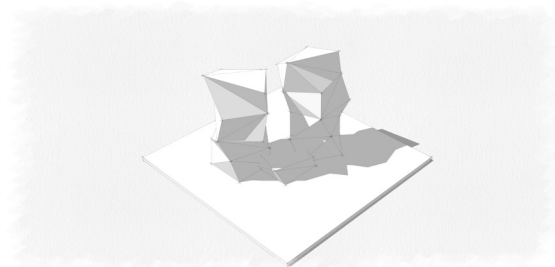
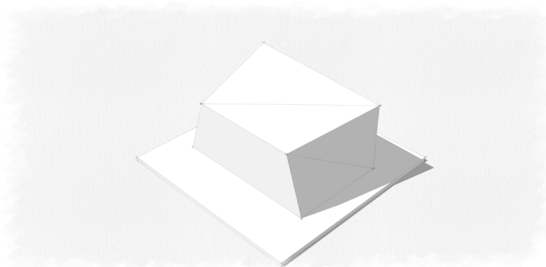
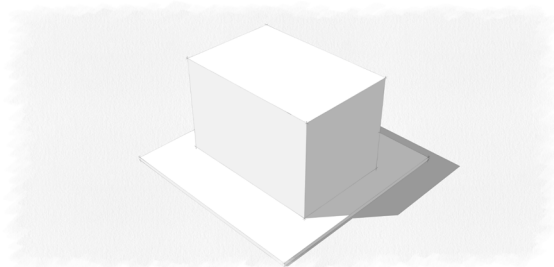
Difference in direction: Difference in the horizontal plane of the building (except for corner joints).



Special elements: Added elements that are not living quarters (staircases, entrances, portals, etc.).



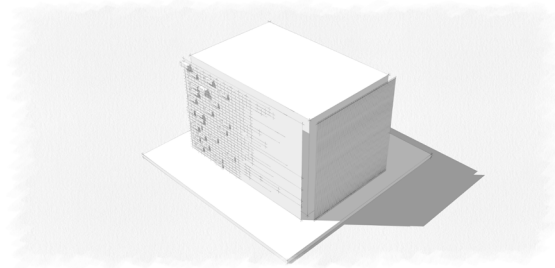
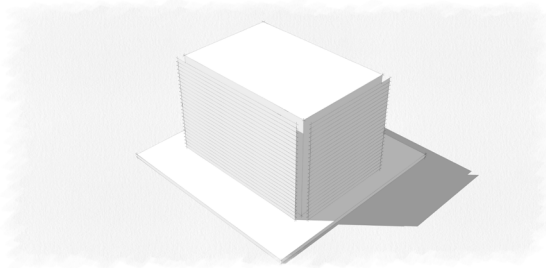
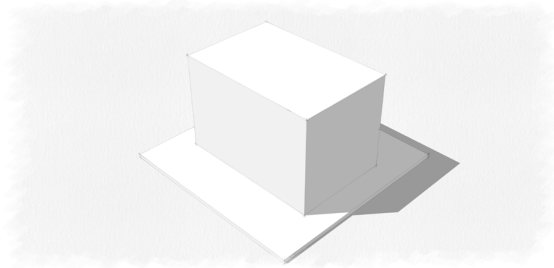
Oblique lines: Oblique lines that visibly differ from the orthogonal (both horizontal and vertical) axes of the building.



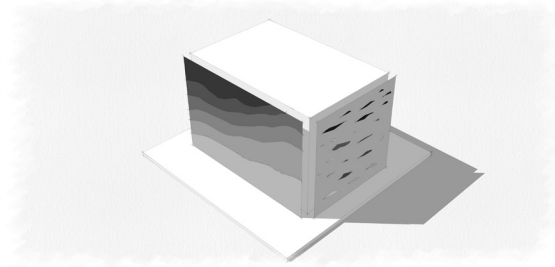
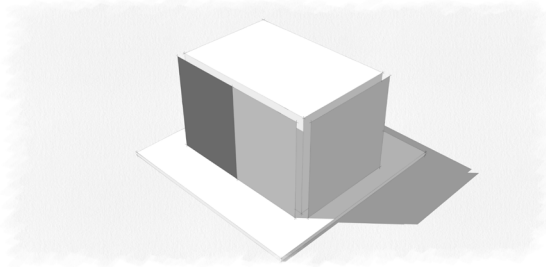
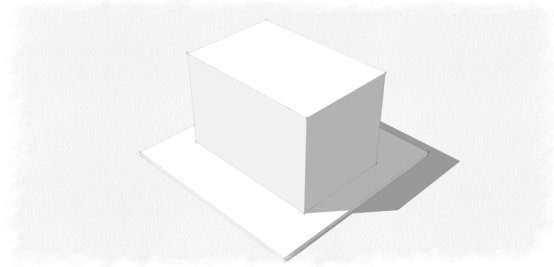
←—————→
complexity

Arch_details

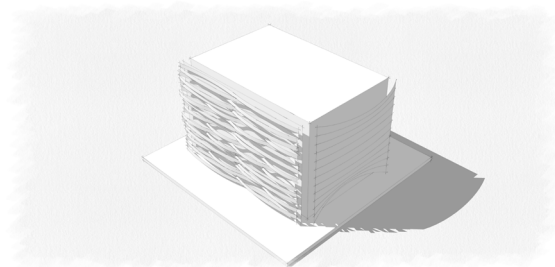
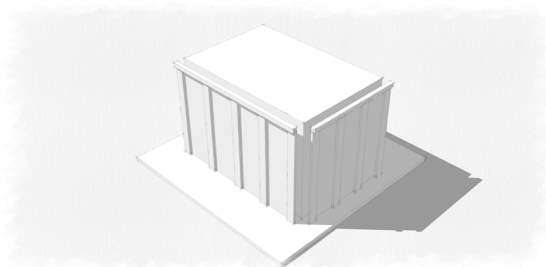
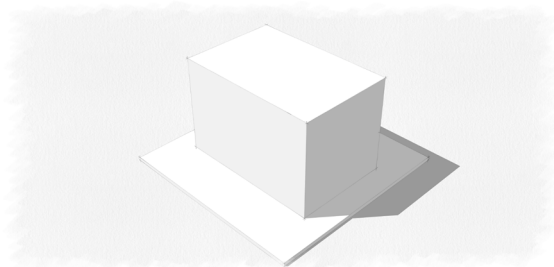
Texture: Variety of applied materials in the façade, ordered by surface structure.



Colour (and brightness): Variety of applied materials in the façade, ordered by colour and brightness.

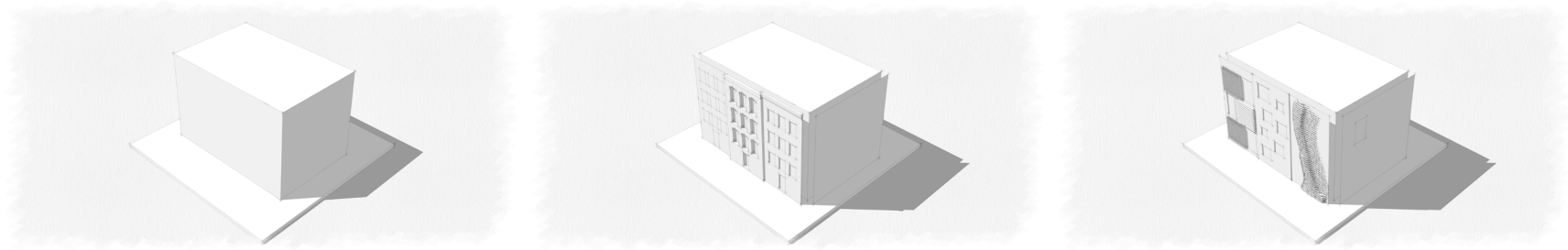


Plasticity: The extent of deviation from the basic flat surface, both horizontal and vertical.



complexity

Articulation: Surface division of the façade into recognizable parts that retain a certain relation with each other.



←—————→
complexity

**Complexity in urban design:
Spaciousness, buildings, and
details.**

Relation with the surrounding urban context, multiple buildings, or building blocks is even more relevant in psycho-perceptual design

It relates to complexity of perceived *scenes* of our field of views

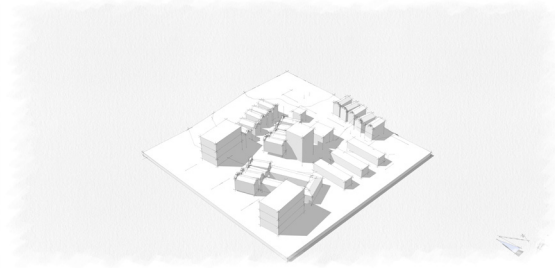
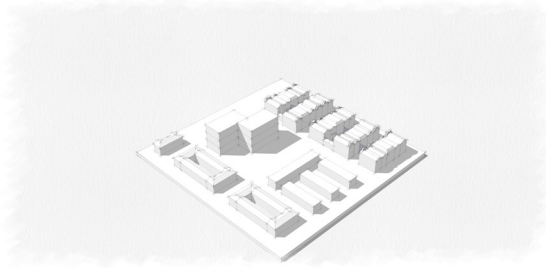
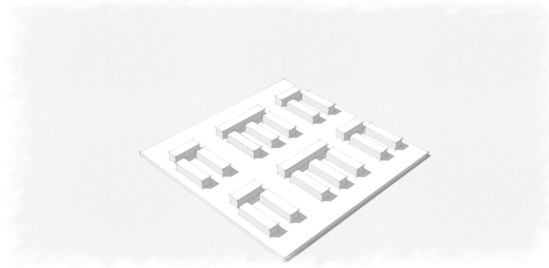
It can make or break the complexity composition:

Too little = visually poor

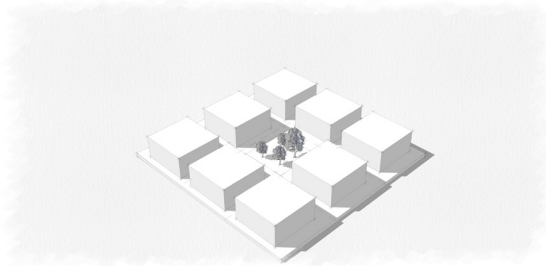
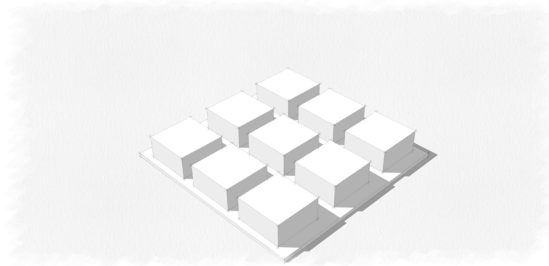
Too much = visual overload

Urb_spaciousness

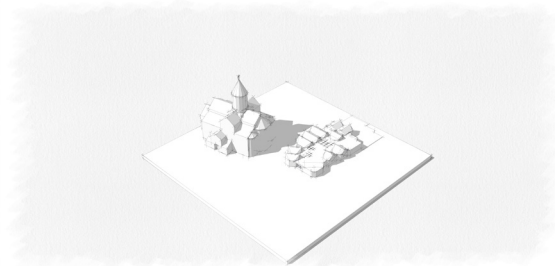
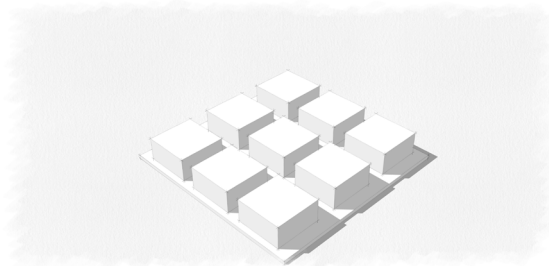
Variety in sequential spaces: Extent in which different urban spaces alternately occur on a route.



Variety in urban spaces: Extent in which different urban spaces simultaneously occur in the area.



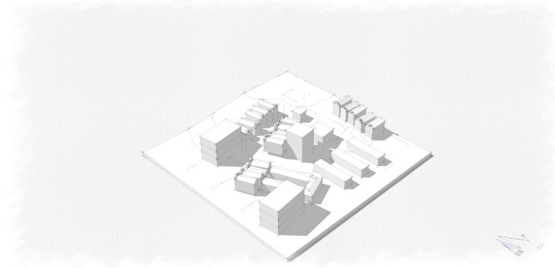
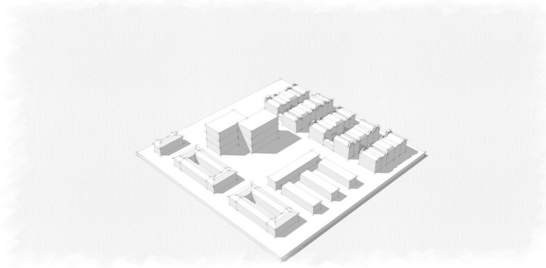
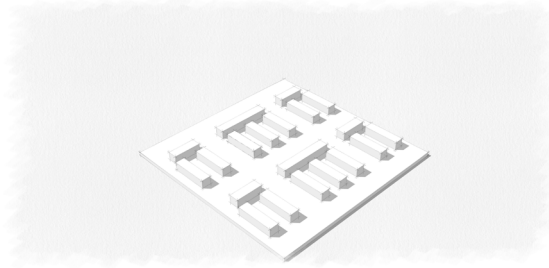
Special spaces: Spaces that differ in both form and function from the usual residential spaces in the area.



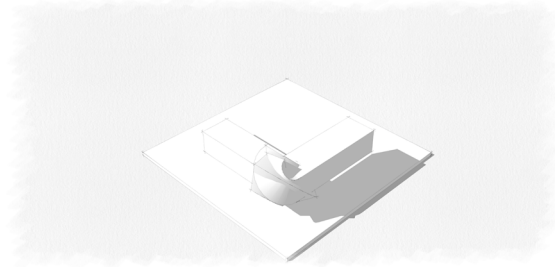
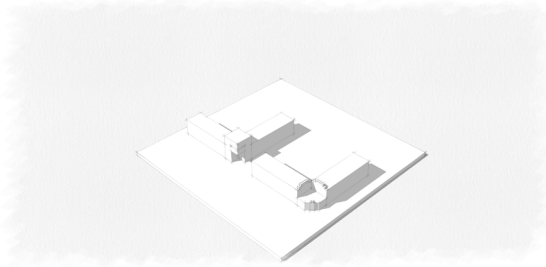
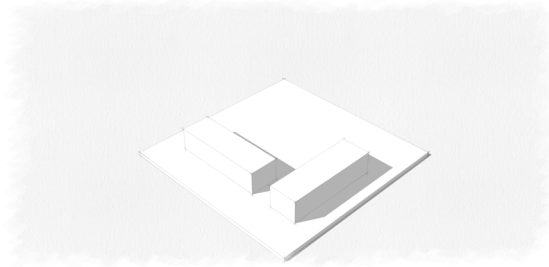
←—————→
complexity

Urb_buildings

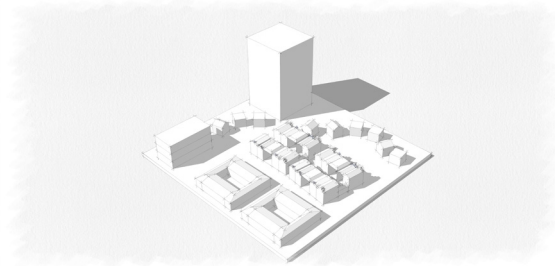
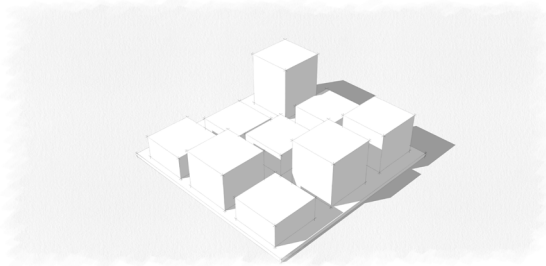
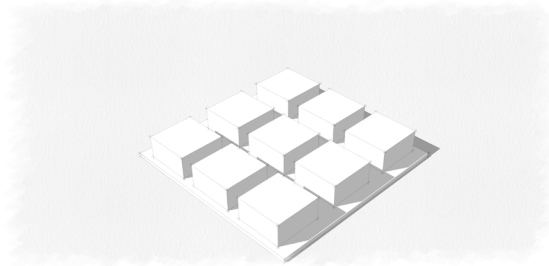
Variety in appearance: Variety and distinctiveness in the occurrence of building appearances in the area.



Corners: The extent of corner connectedness of buildings, and their appearances.

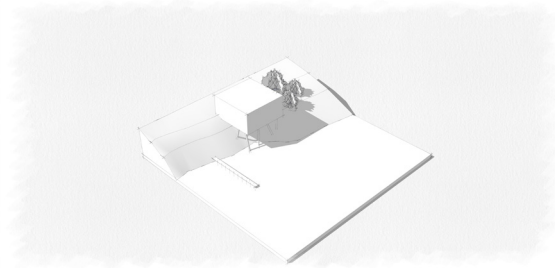
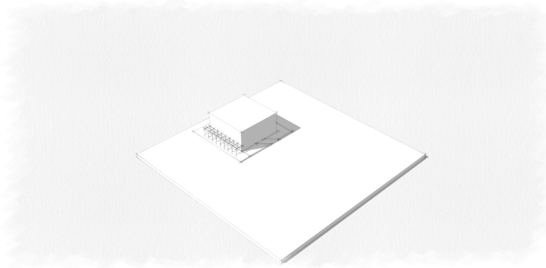
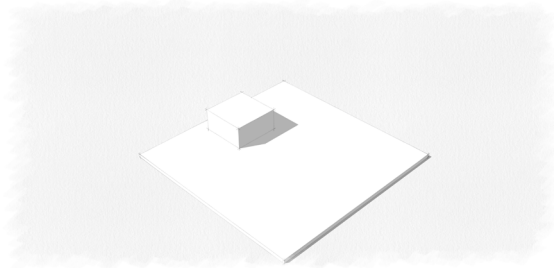


Variety in type: Extent in which different building types occur.

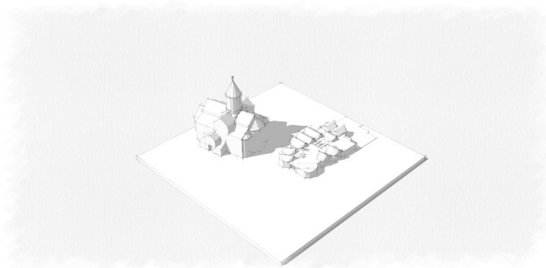
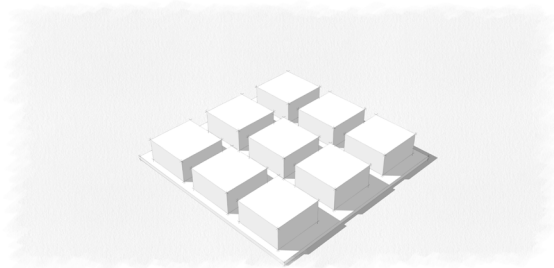


←—————→
complexity

Transition building- surrounding: The way the building is situated in- and transitions to its surroundings.



Special buildings: Occurrence of special buildings such as shops, libraries, schools, churches, etc.



←—————→
complexity

Complexity of relative motion

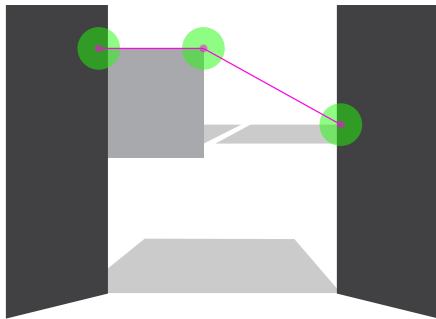
Our visual system is set to track and detect changes in the visual field.

Apparent pattern of motion, which is referred to as the optical flow.

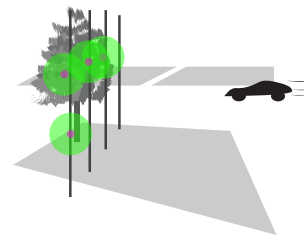
Change of this flow, rhythm & datum, is essential, but often neglected.

OBJ/ SURFACE
motion

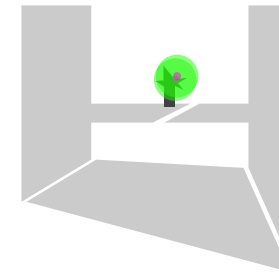
rapid disruptions / fast moving obj



object-screen
relative motion / moving obj



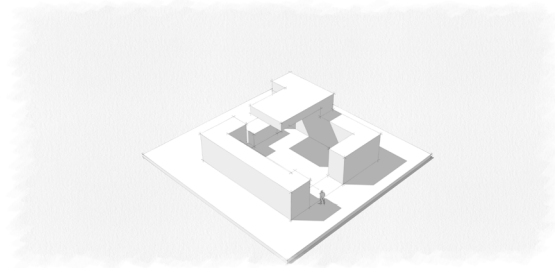
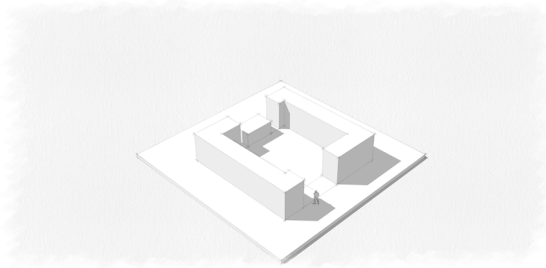
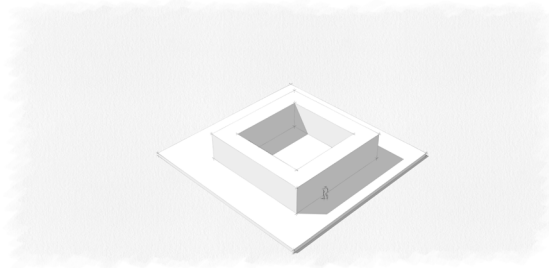
no/ low motion



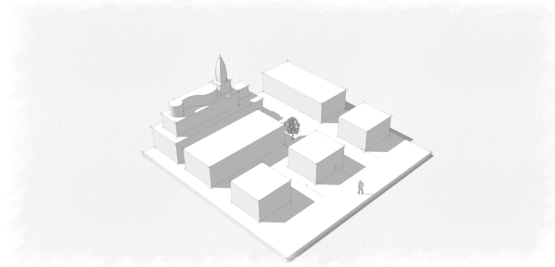
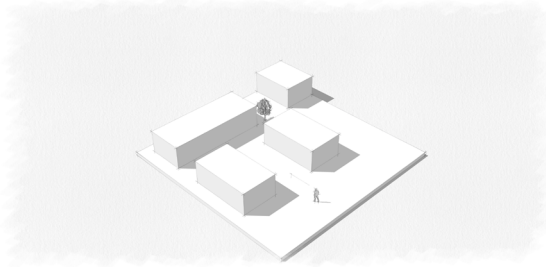
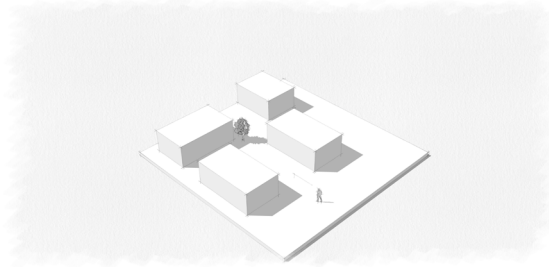
Too little = predictable
Too much = scattered flow, messy

Spc_motion

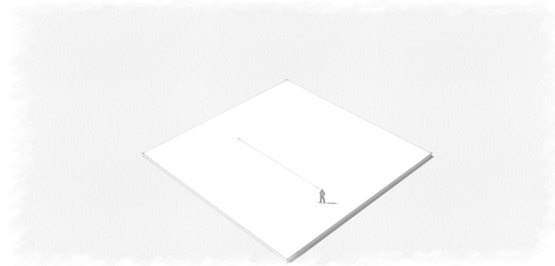
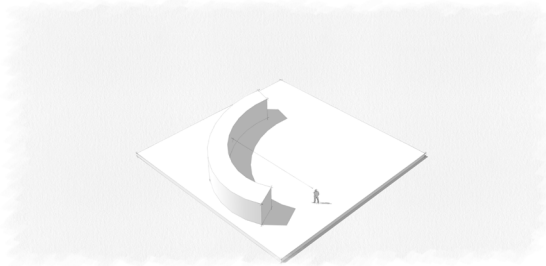
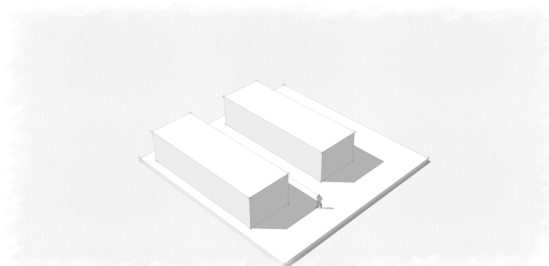
Enclosure: Extent to which the scene deviates from an enclosed (convex) overview.



Expectation and surprise: Variety in which the composition of architectural- and/or urban design elements (the scene) provides occlusion and revelation.



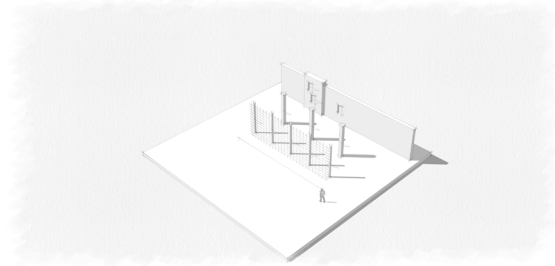
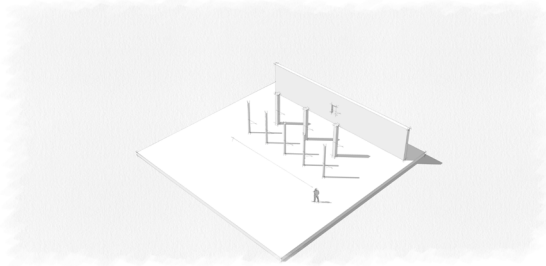
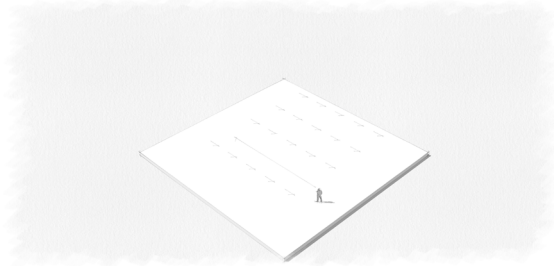
Vanishing point: Extent to which the scene deviates from a clear vanishing point, where lines seem to converge.



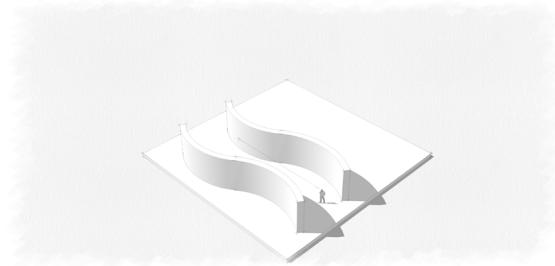
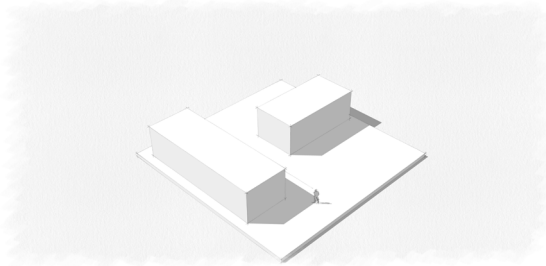
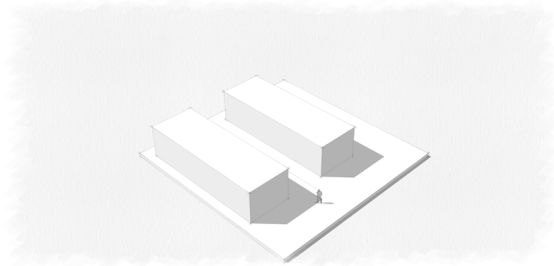
←————— complexity —————→

Fig_ground_motion

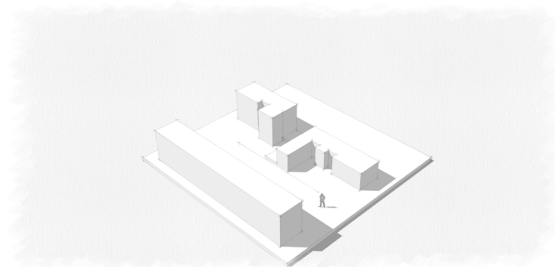
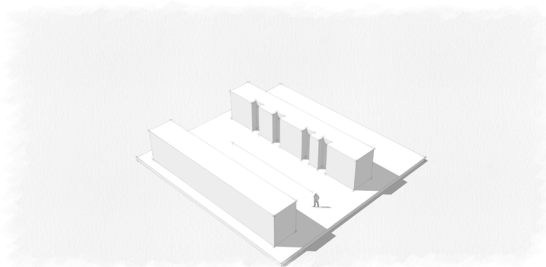
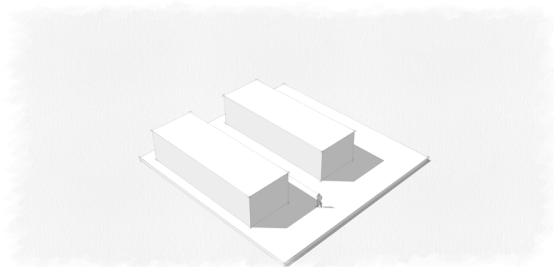
Object placement: The variety in type and rhythm of object placement in relation to the background.



Direction of flow: Extent to which longitudinal flow deviates with the occurrence of lateral (or radial flows). architectural- and/or urban design elements (the scene) provides occlusion and revelation.



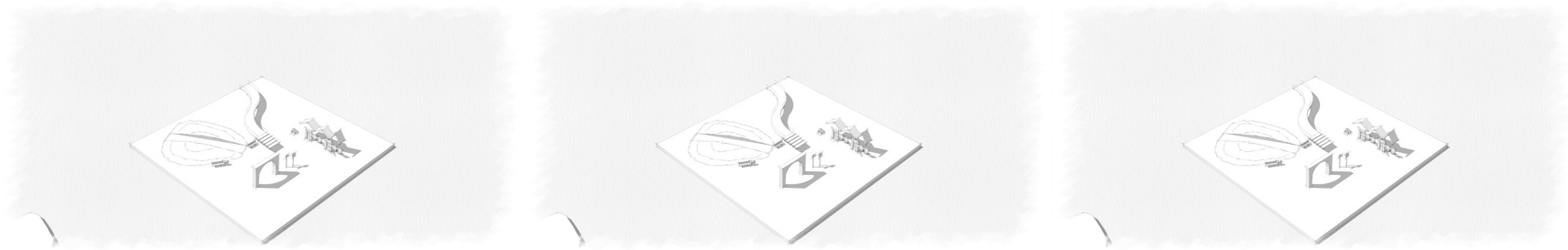
Flow interruption: Variety in rapid changes of continuous flow



←————— complexity —————→

Affordances

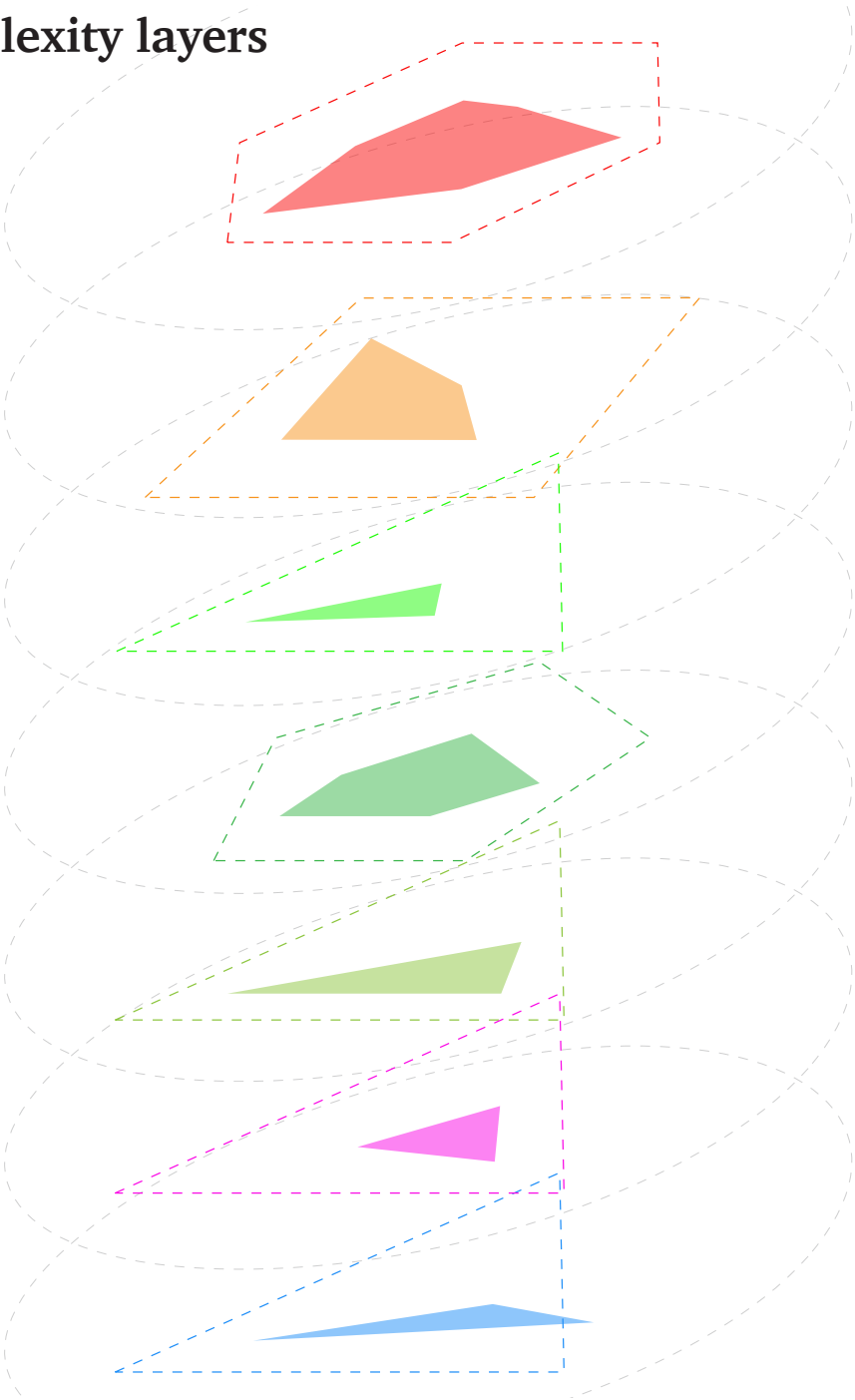
Affordances: Variety and clarity in surface or object interaction



complexity

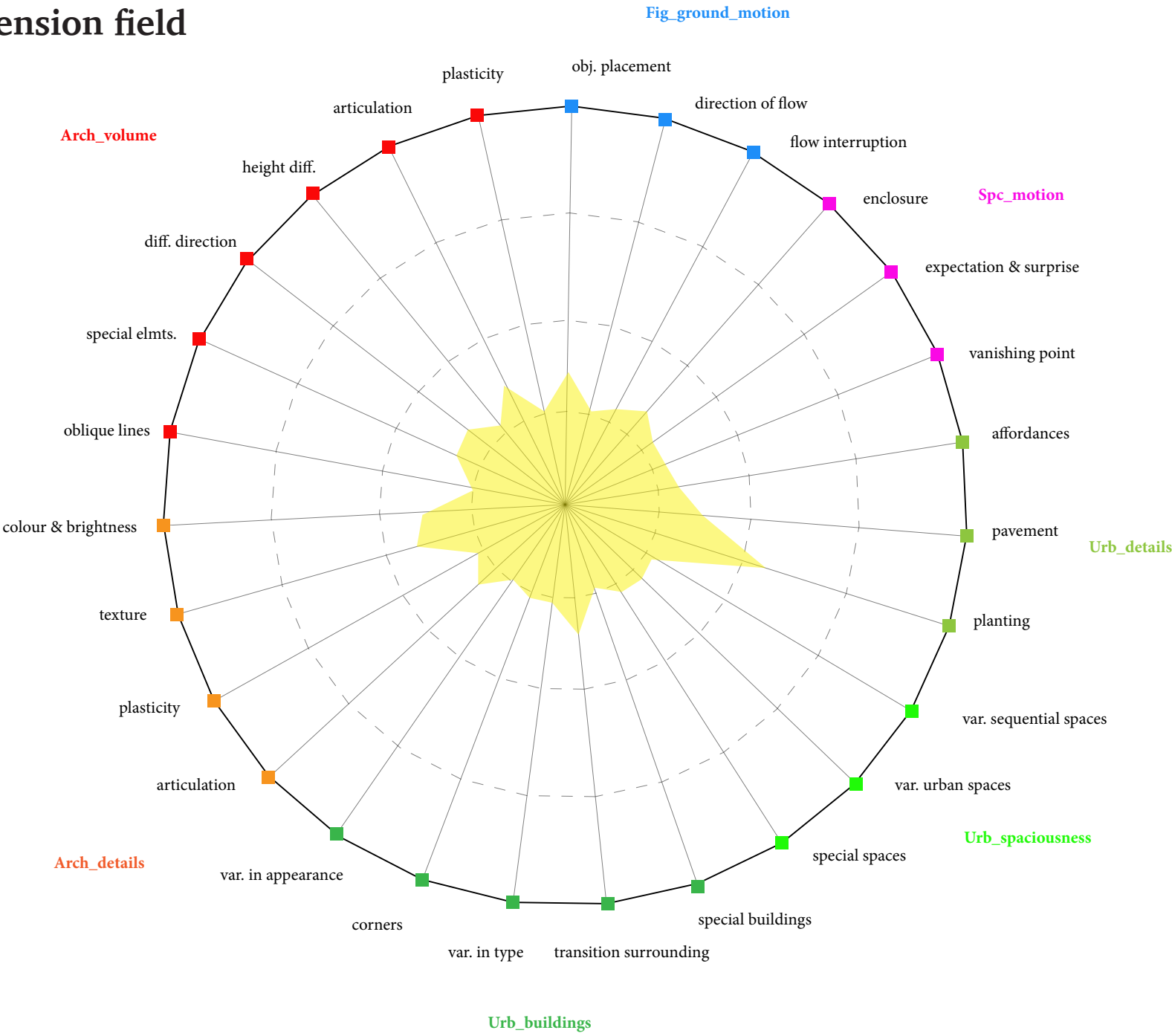
spatial-perceptual complexity layers

To summarize:



- Arch_volume**
 - plasticity
 - articulation
 - height diff.
 - diff. direction
 - special elmts.
 - oblique lines
- Arch_details**
 - colour & brightness
 - texture
 - plasticity
 - articulation
- Urb_spaciousness**
 - var. sequential spaces
 - var. urban spaces
 - special spaces
- Urb_buildings**
 - var. in appearance
 - corners
 - var. in type
 - transition surrounding
 - special buildings
- Urb_details**
 - planting
 - pavement
 - affordances
- Spc_motion**
 - enclosure
 - expectation & surprise
 - vanishing point
- Fig_ground_motion**
 - obj. placement
 - direction of flow
 - flow interruption

spatial-perceptual tension field



subquestion 3:

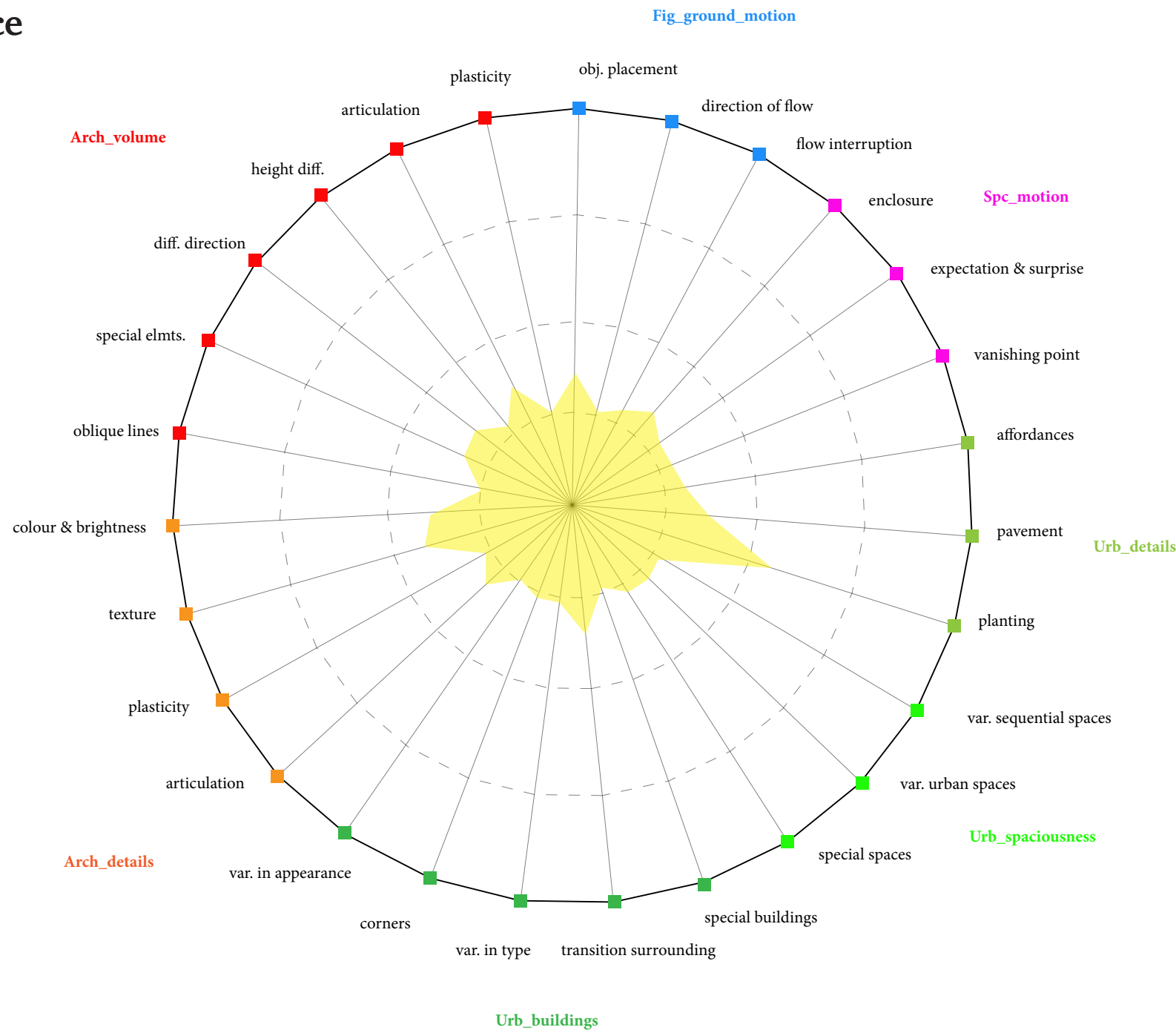
How can we express the findings in design?

Example case: Mastbos Amsterdam Noord

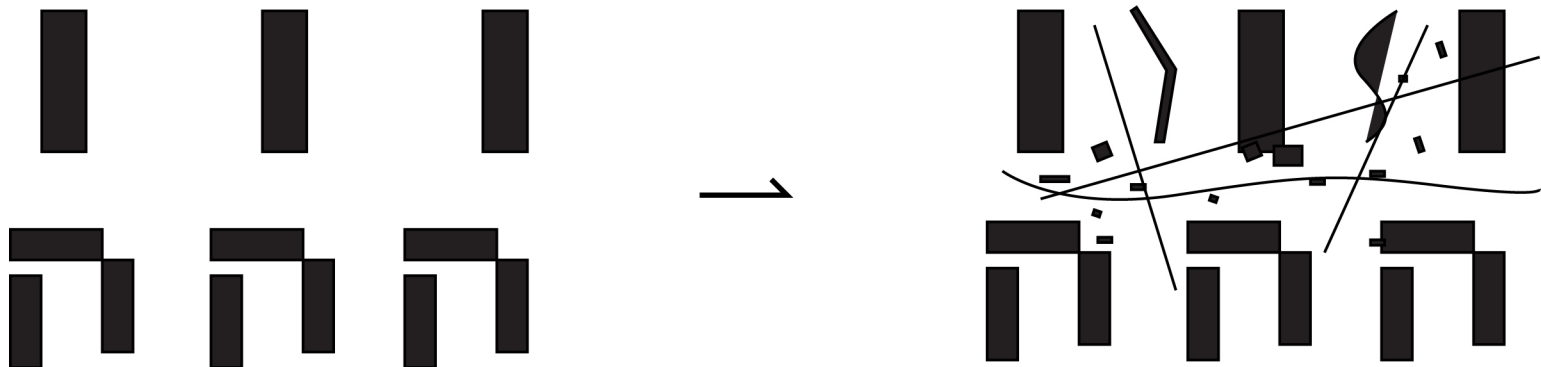


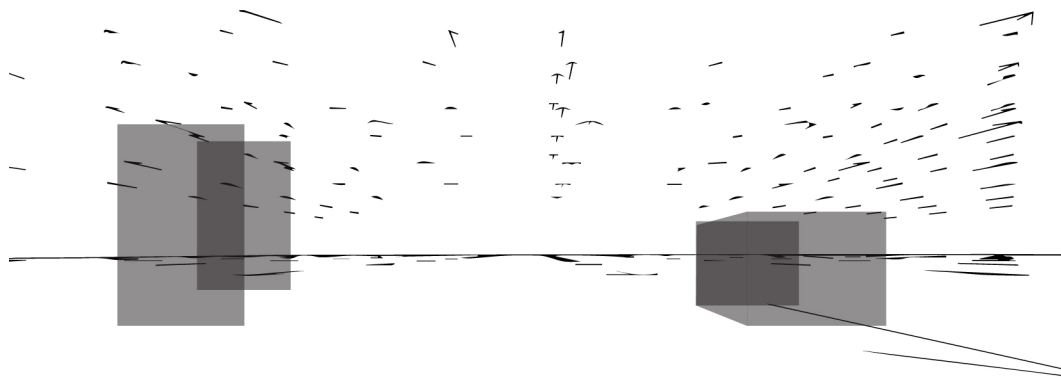


tension field balance

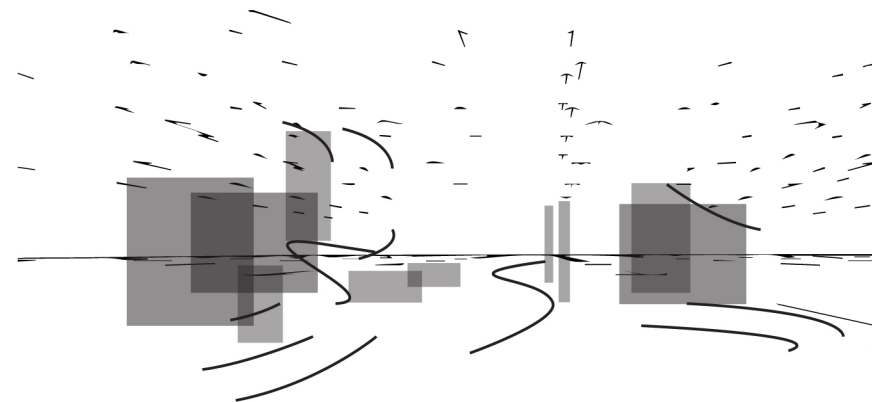


concept





From steady optic flow

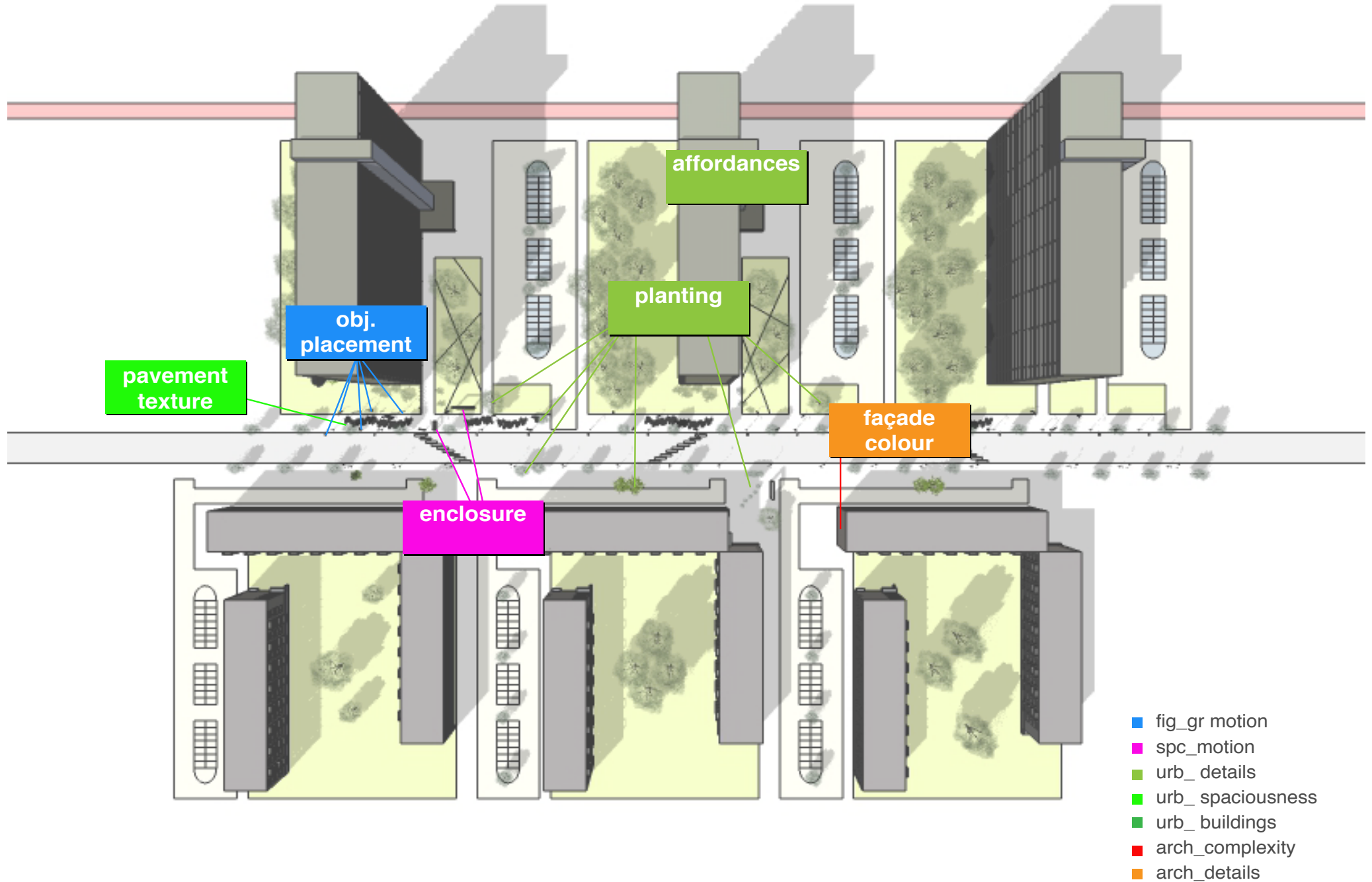


to datum & disruptive flow



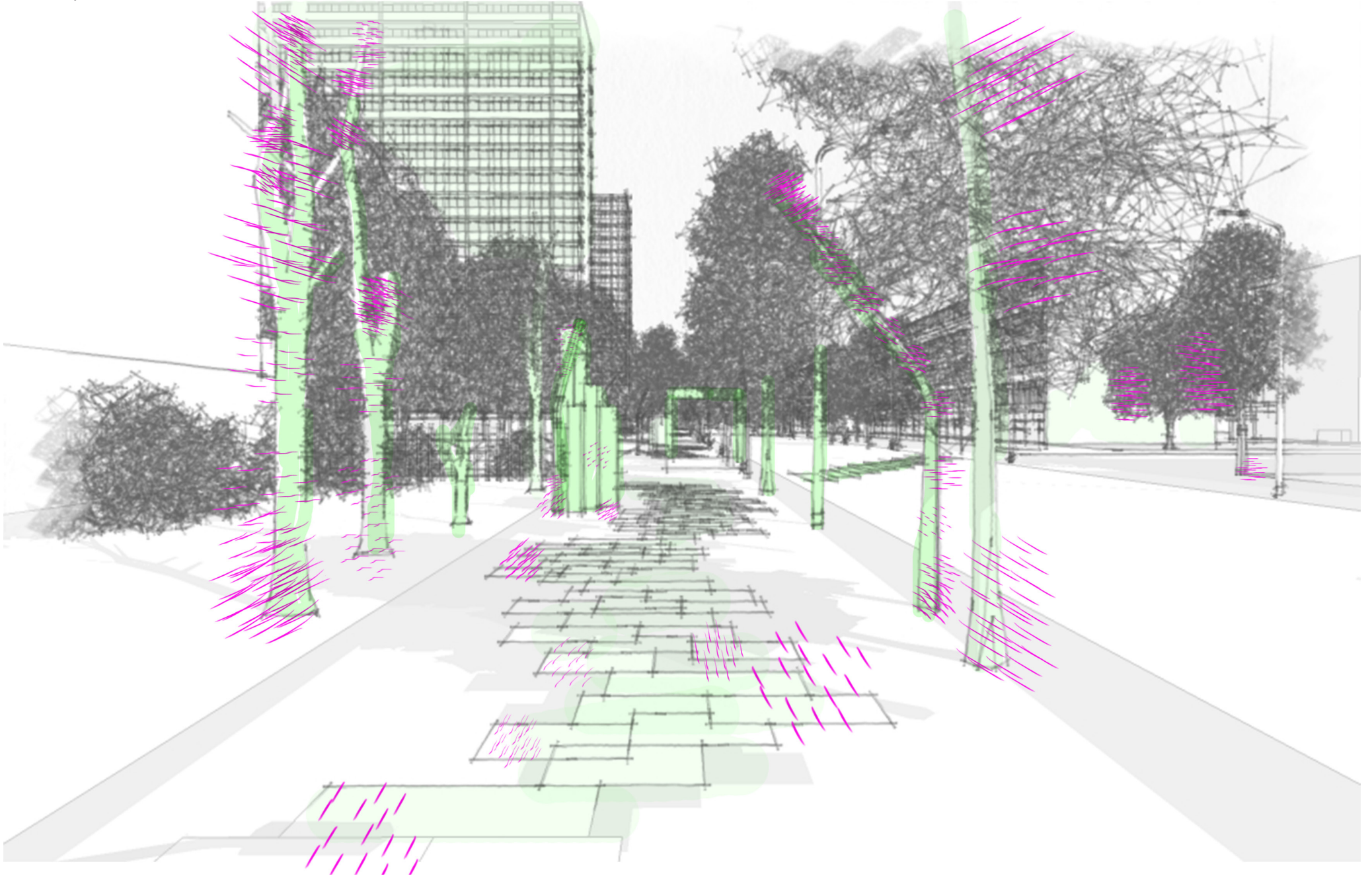


minimum intervention

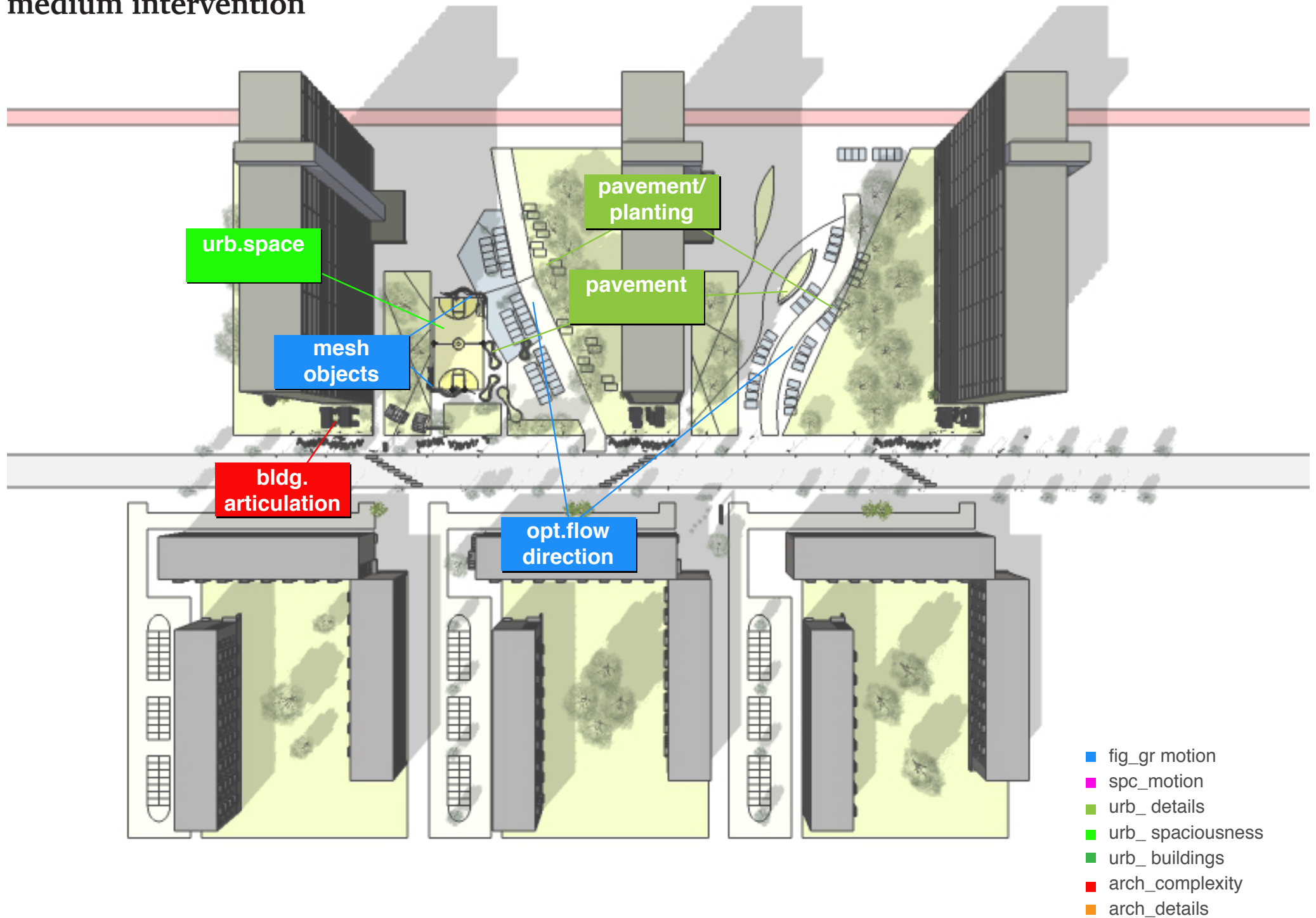


information complexity

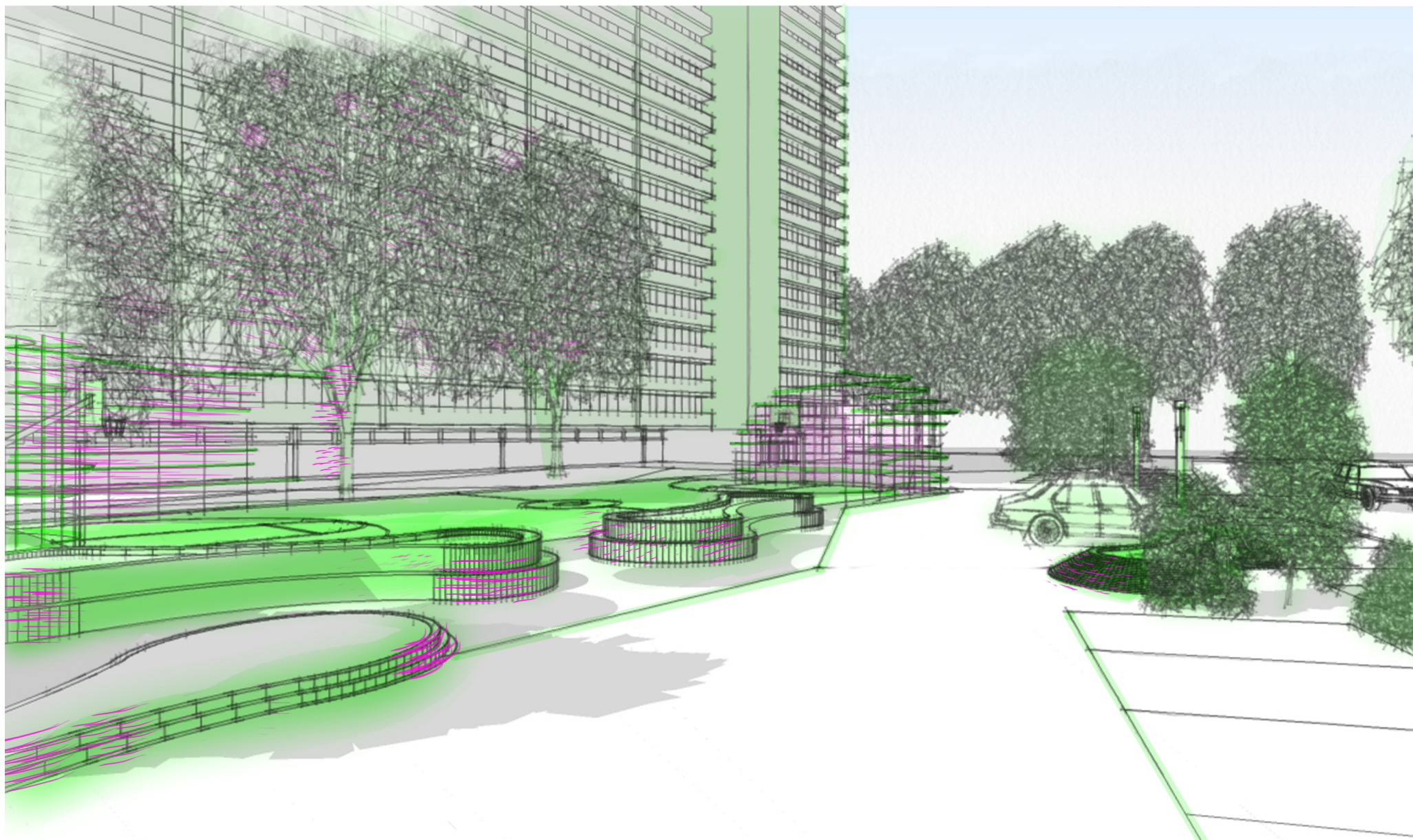
optic flow



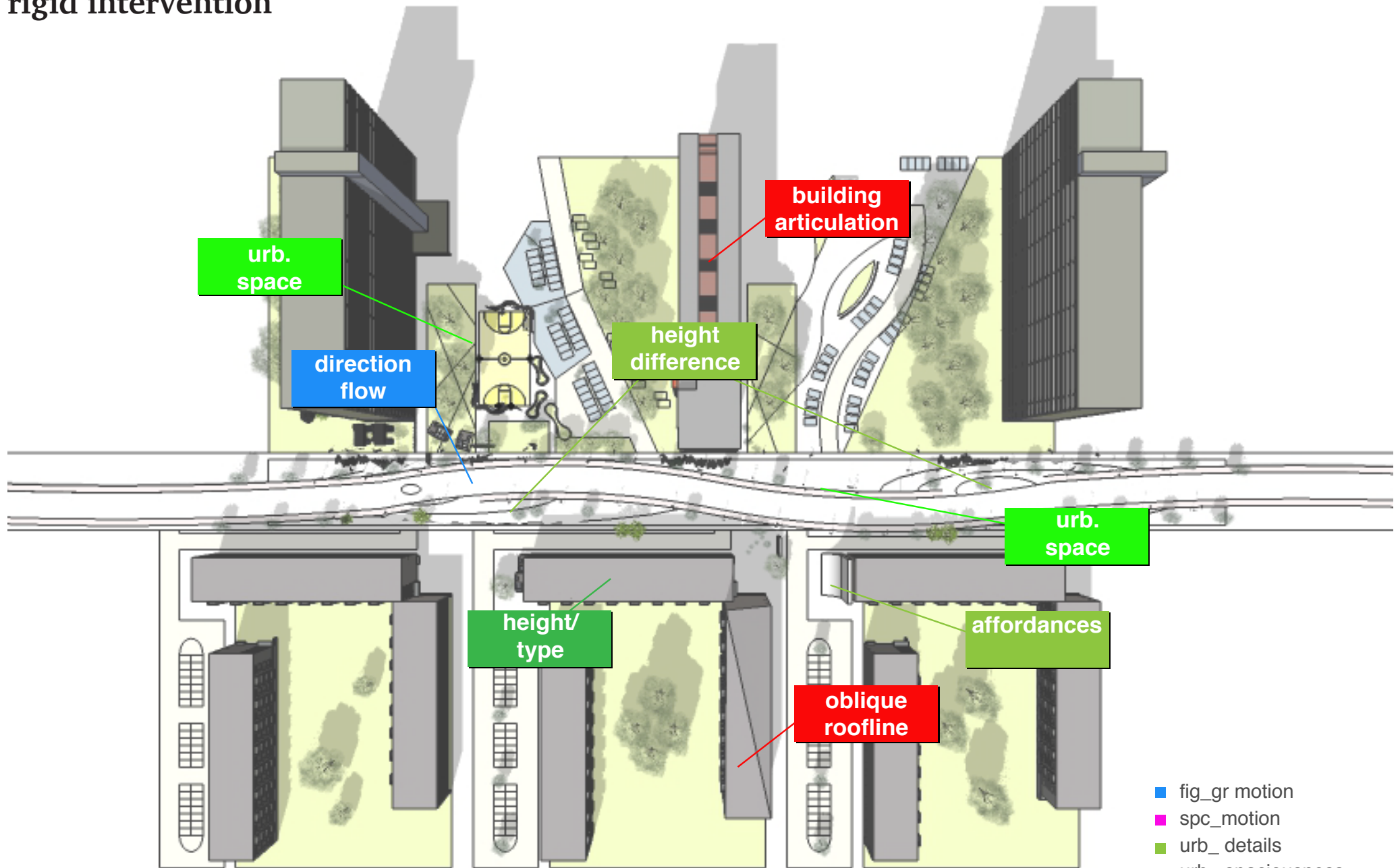
medium intervention



- information complexity
- optic flow



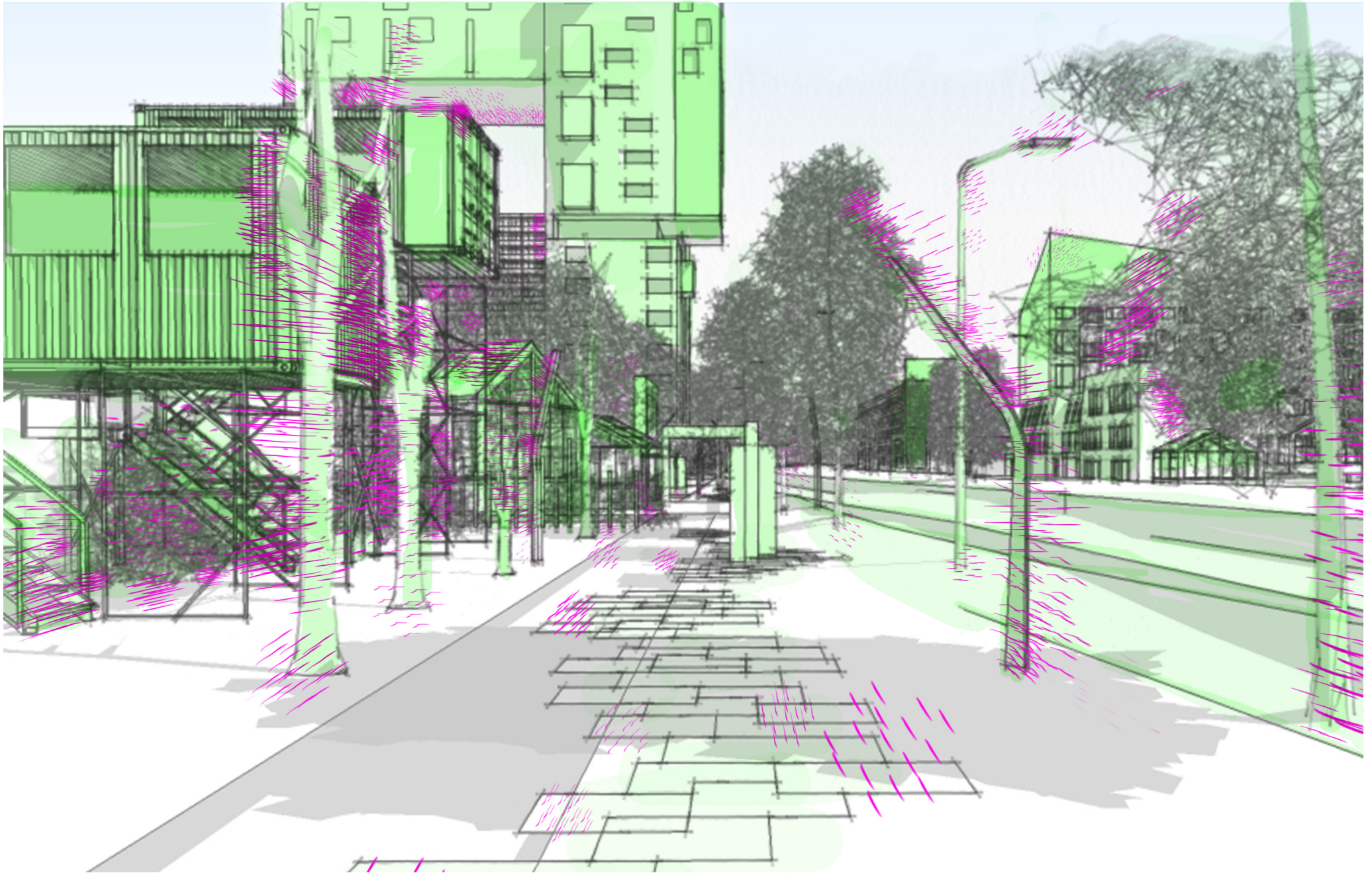
rigid intervention



- fig_gr motion
- spc_motion
- urb_details
- urb_spaciousness
- urb_buildings
- arch_complexity
- arch_details

information complexity

optic flow



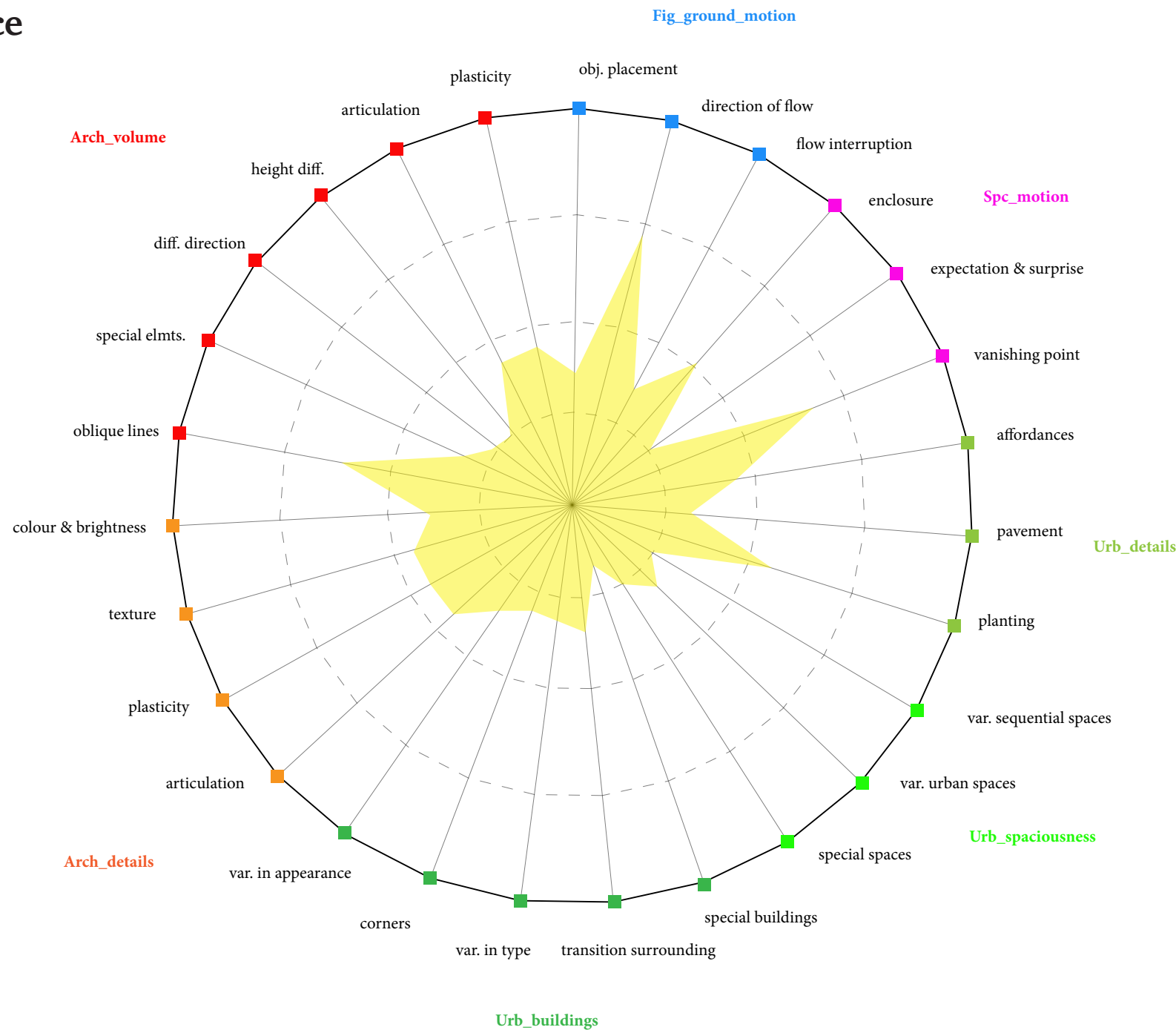


Example case: De Kamp

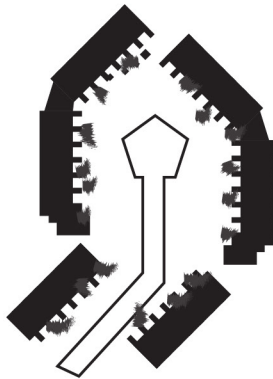




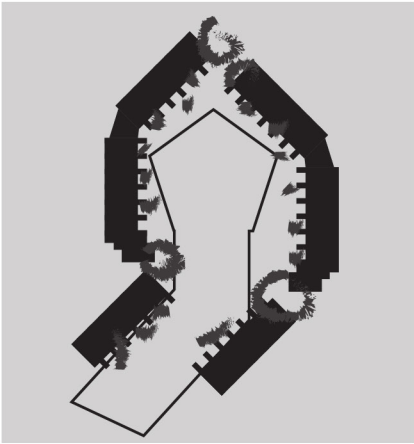
tension field balance

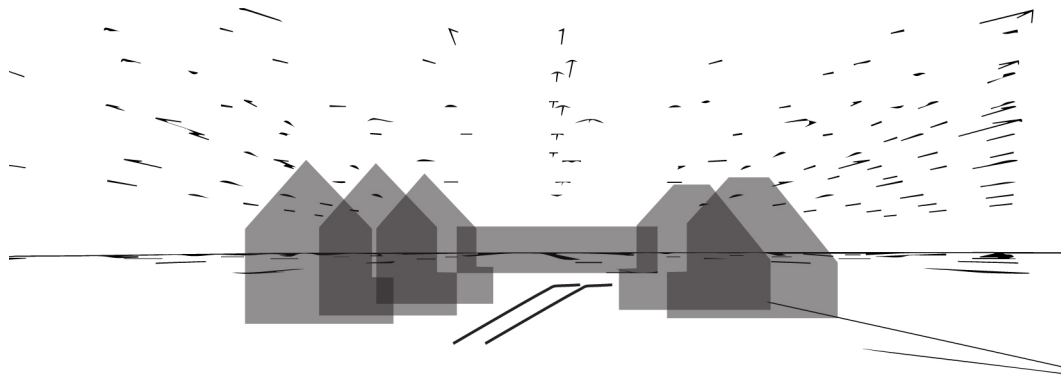


concept

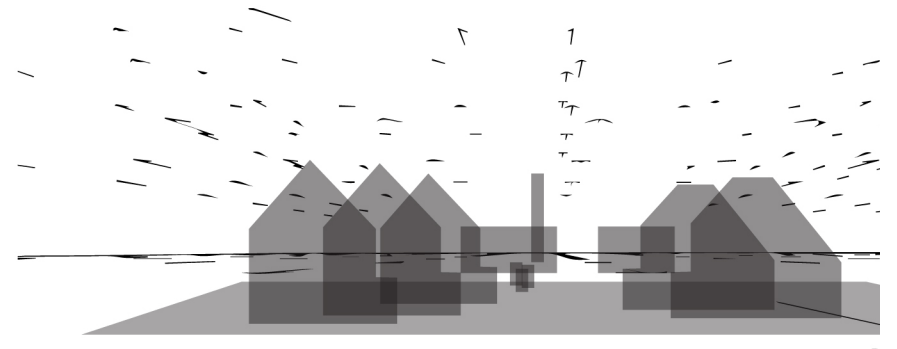


1





From visual messy

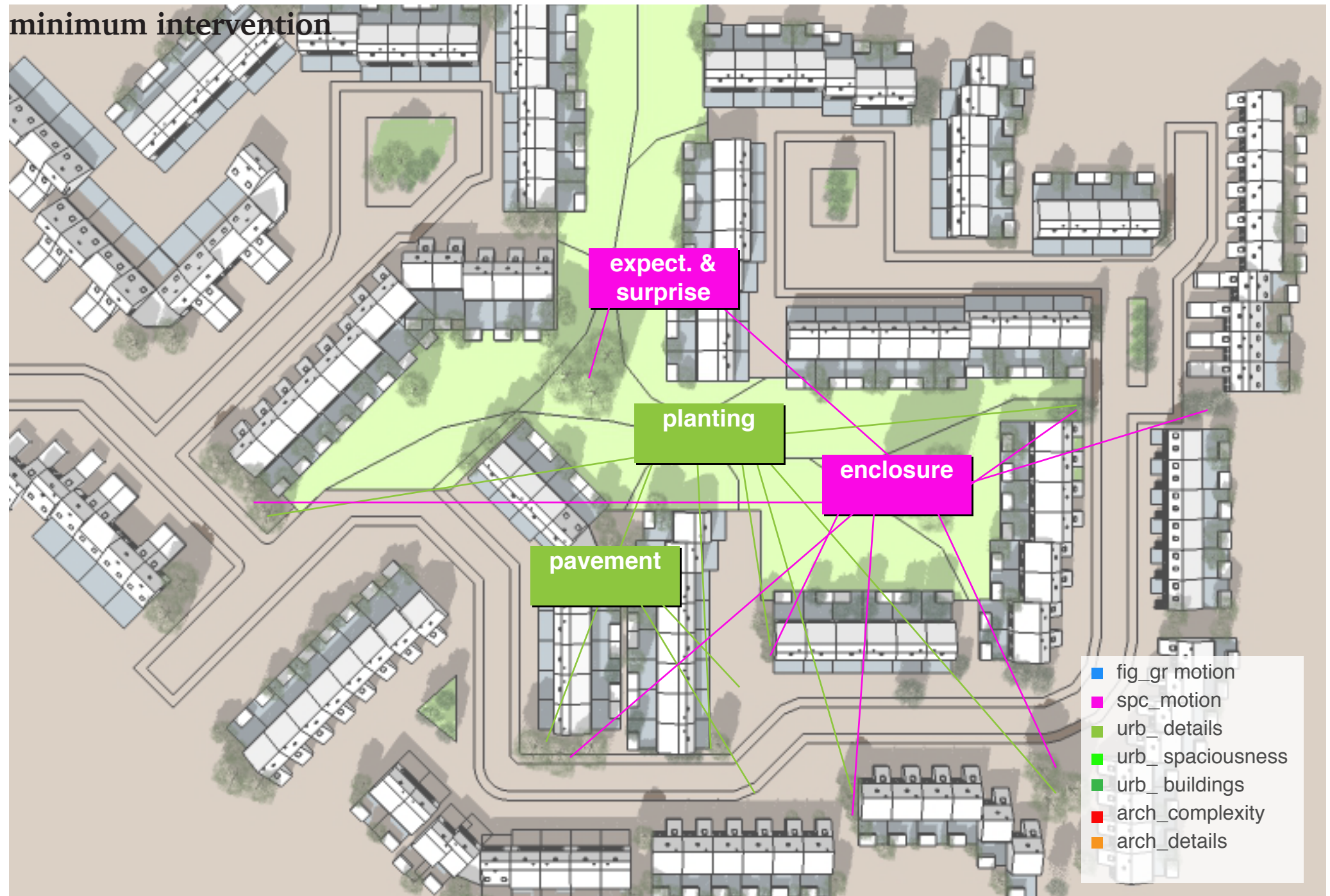


to coherent flow





minimum intervention

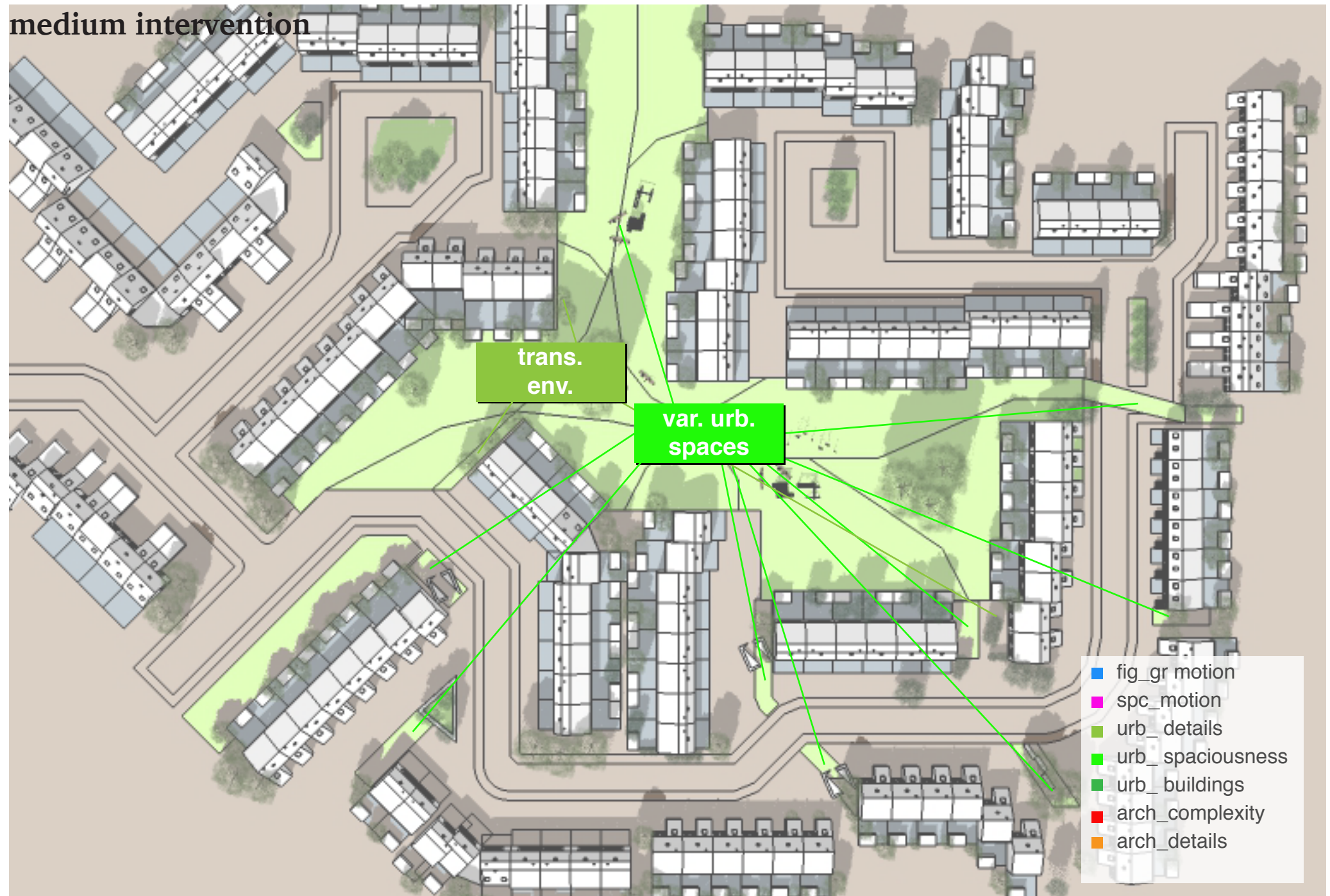


information complexity

optic flow

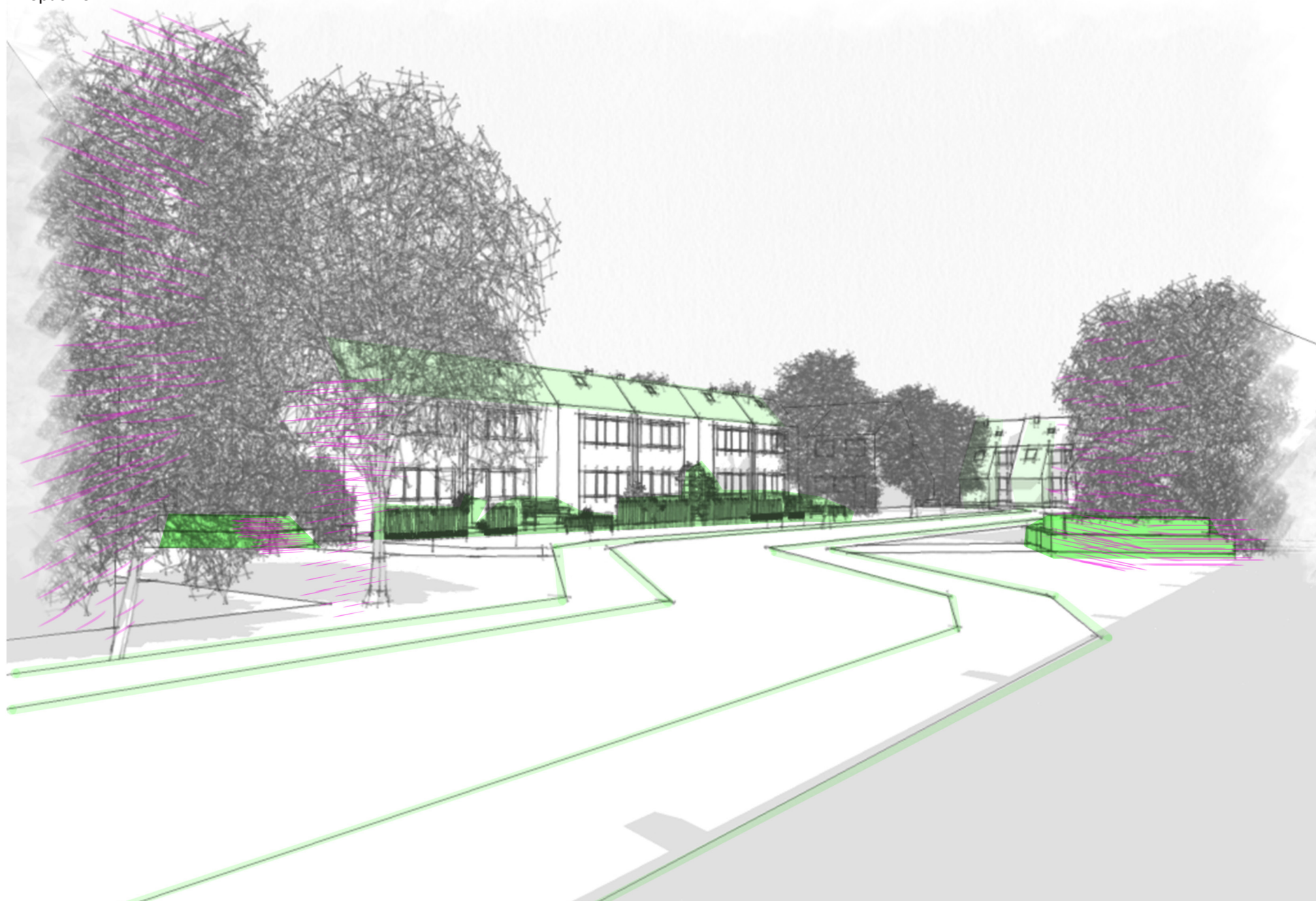


medium intervention

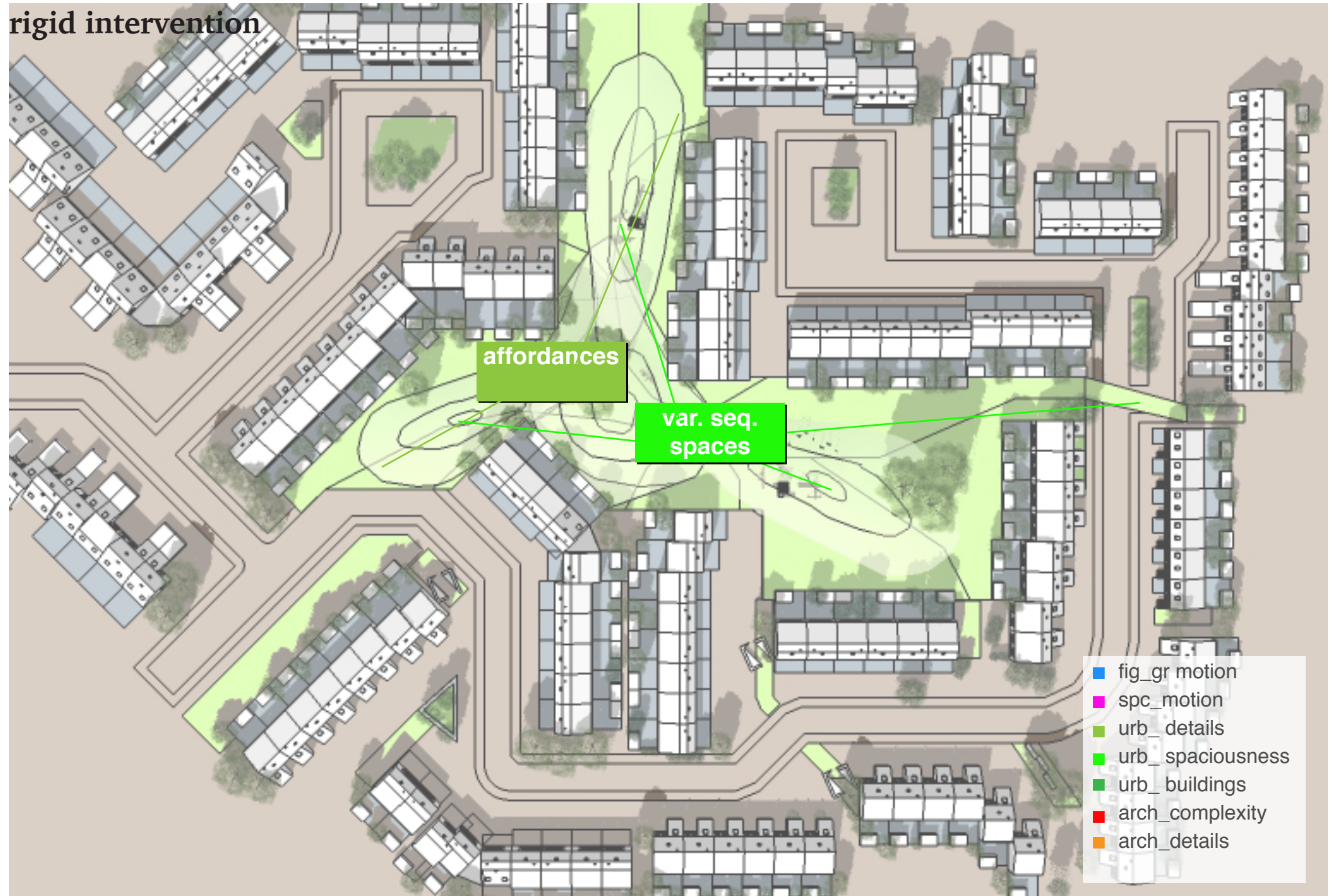


information complexity

optic flow

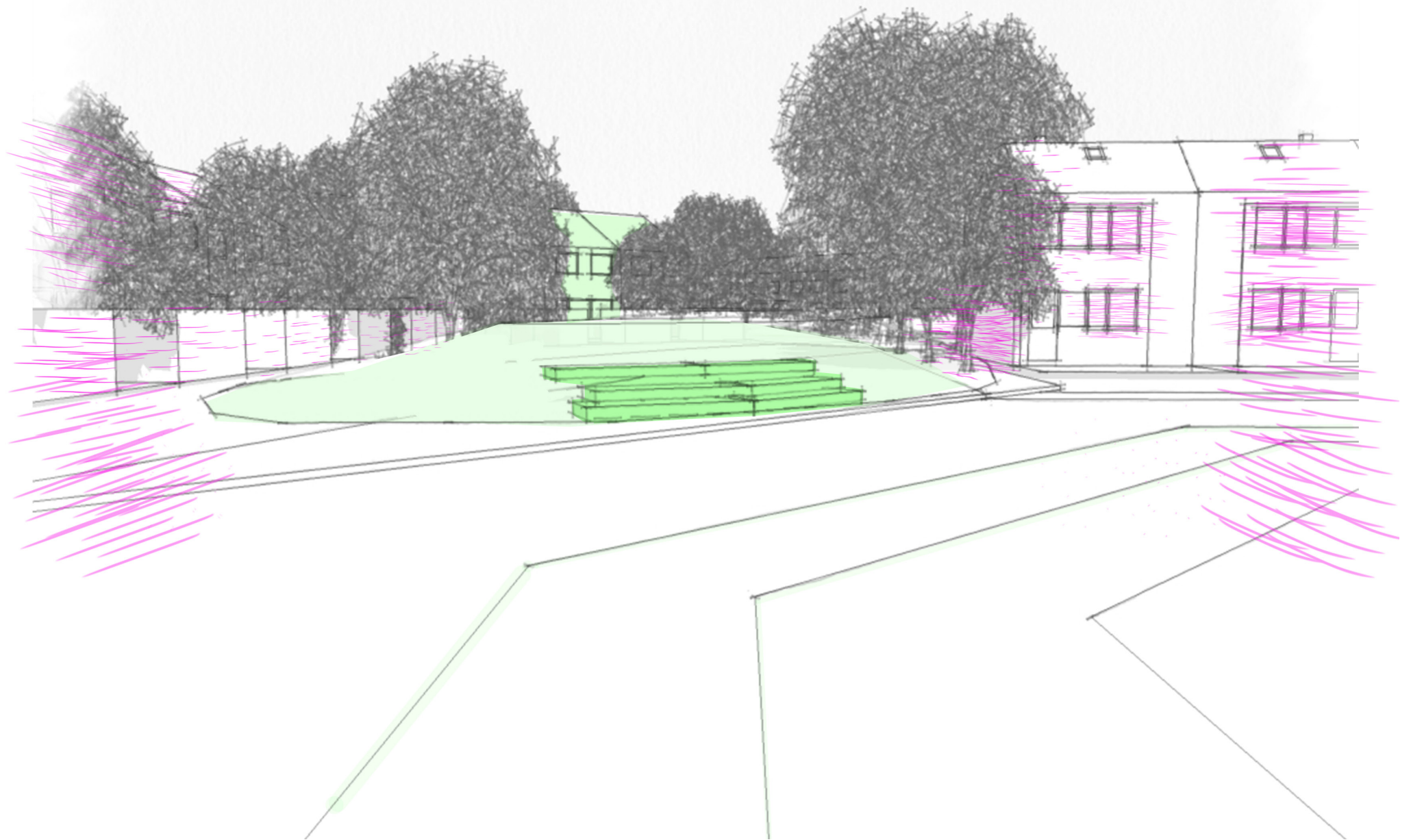


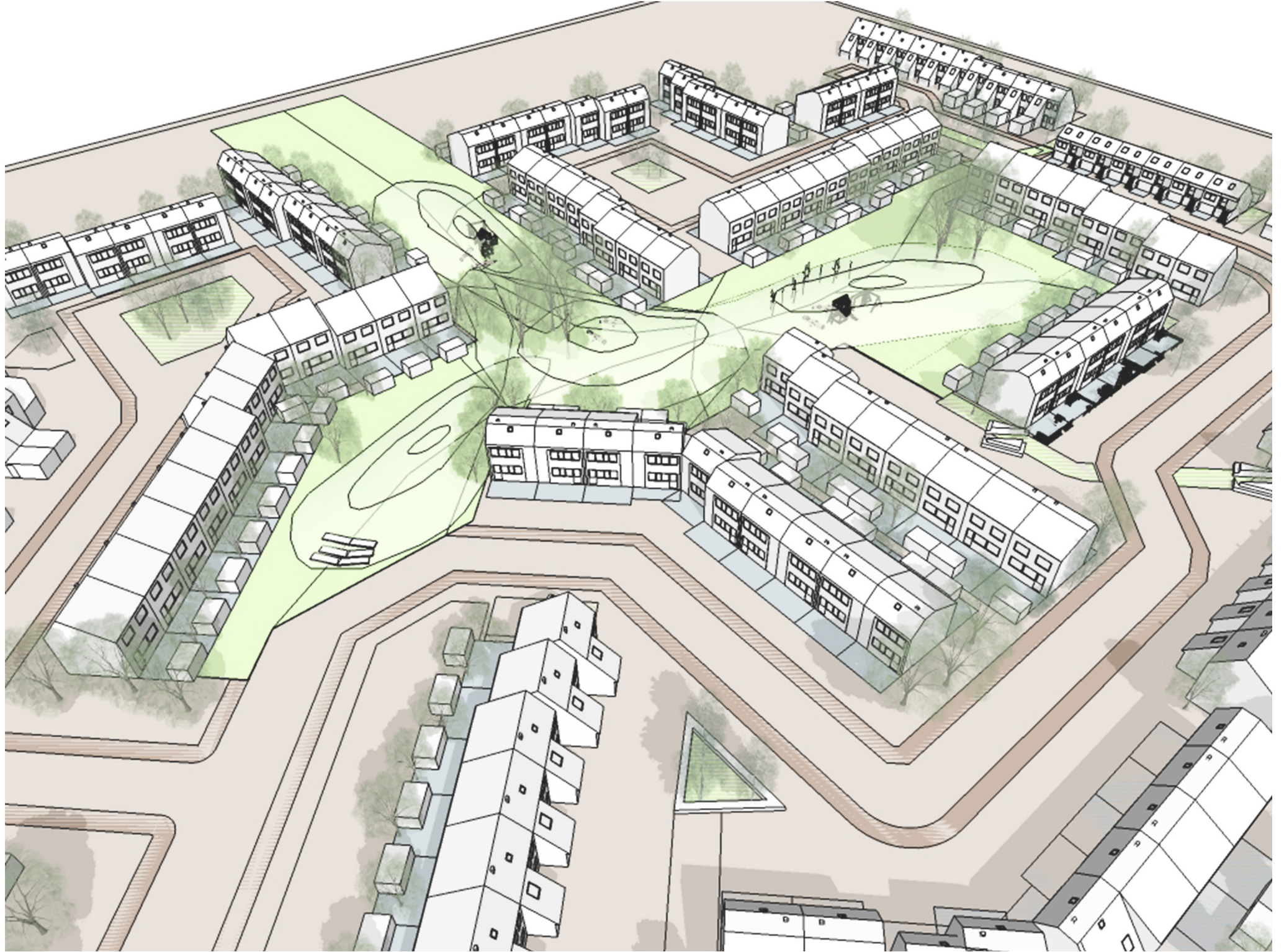
rigid intervention



information complexity

optic flow





conclusions

Can we find patterns of gaze behaviour, change in EEG freq. bands, and gazed elements?

- **SEE's - low alertness** involve quick-scanning coherent (enclosed o-type, vanishing points, occlusions, and contours).
- **SEE's - high alertness** involve irregularity and change
- **PQA's - low alertness** involve paths and natural surfaces
- **PQA's - high alertness** involve more complex agents

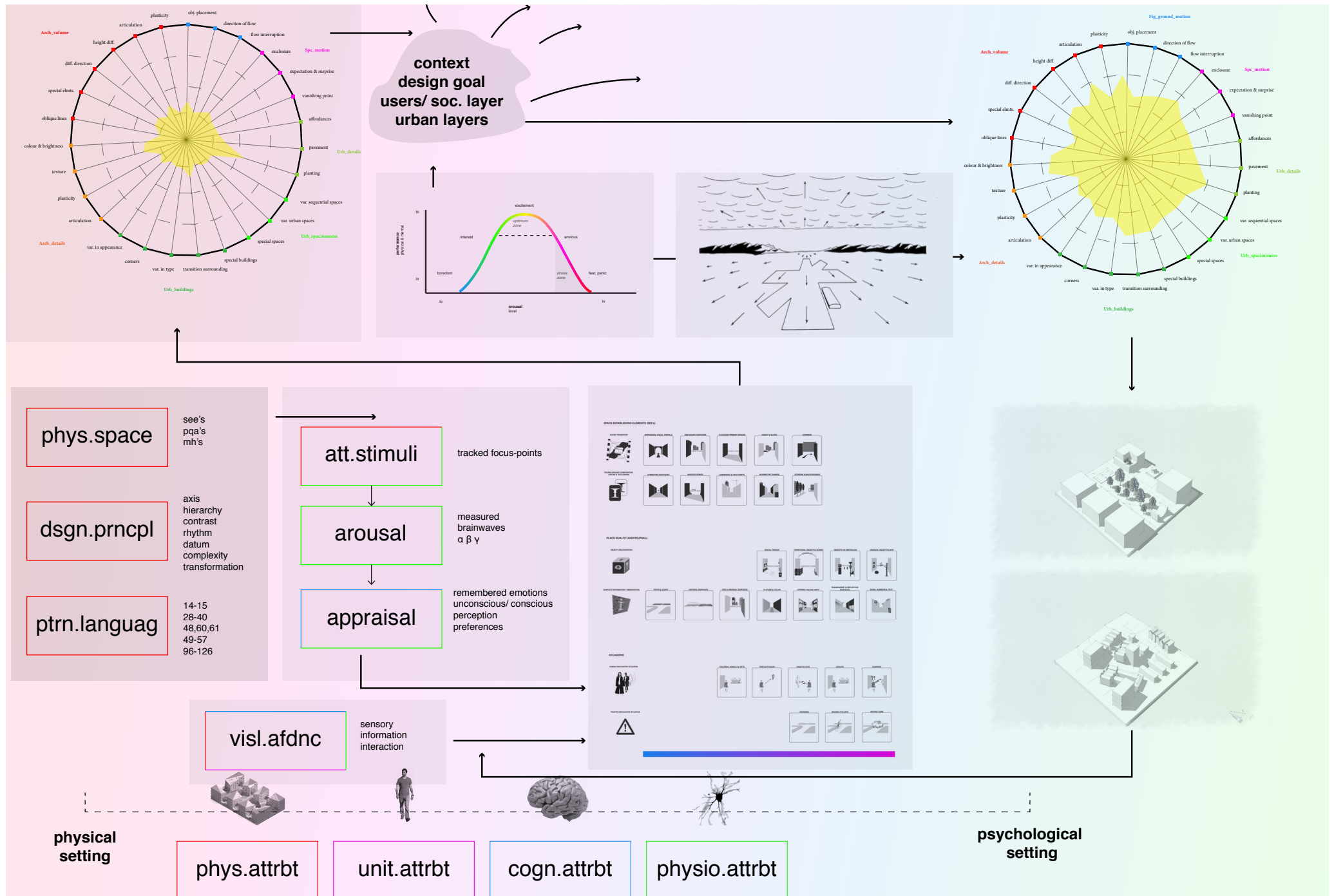
What specific attributes do they have in common?

- **Dynamic spatial events** in relation to SEE's, PQA's, and occasions, rather than static spatial elements
- **Complexity of information potency** (architectural and urban complexity)
- **Complexity of relative motion** (Optical flow)

How can we express it in urban design?

- Use guidelines to determine which scenes score low/high in the coherence - complexity tension field
- Depending on the context & strived goal, increase or decrease information potency of within the tension field

Which **spatial elements** are essential in influencing our visual **perception** of urban **environ-ments**, and how can we explicate and express these elements in **urban design**?



limits

- Commercial grade equipment vs. medical equipment and methods
- Eventually used data is based on videos, not the visual world
- Generalizability (low n, applicability to other urban environments)
- Focus is on influencing visual perception. Actual design requires design thinking in combination with other urban design layers, e.g. the, urban context, social context, ecology, etc.

potential

- Different approach to urban design (see the environment as affordances & sensory information)
- Can be used as design input and evaluation method
- This approach sees the environment as sets of complexity sensory information and the balance between the tension field, however beauty remains subjective:

“Mooi is anders”

Thank you

questions?