Columbia University GSAPP
Spring 2019
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ARCHA4432_001
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Wed 7:00 - 9:00PM

Building Sense: Provocations from Neuroscience

Form, structure, system, scale, environment. This is the language of Architecture. But these concepts are also fundamental to other rapidly advancing fields including Neuroscience. As the properties of sensing, adapting and decision-making inherent to the nervous system are elucidated and described, the potential for more intelligent, evolving, conscious and resilient buildings will no doubt emerge. Will architects however, be equipped to fully contribute and drive design forward if engagement with these terms remains locked within a lexicon limited to analogy and metaphor?

In this seminar, an *architect* and a *neuroscientist* explore convergent concepts from their respective fields and critique their default meanings. By exploring how these ideas are understood from a neuroscientific perspective we will speculate concepts and definitions that could be incorporated into architecture and reciprocally, define the limits of where architecture holds ground.

This seminar does not propose a 'neuro-architecture' but rather asks the question:

Considering the profound capacity of the built environment to modulate sensory perception and behavior, can architects afford *not* to pay attention to neuroscience's theoretical models of the nervous system?

This class is structured as a conversation between *neuroscientist* and *architect*. Foundational principles of neuroscience will be surveyed in weekly readings providing an overview of current theories of how we think about the nervous system. In-class presentations and readings will be catalysts for discussion. Active student participation is expected and required. Students will submit two questions based on the weekly readings the night before class. These questions will be incorporated into the class discussion. The required course submission will be a written or graphic/computational investigation of topics covered during the semester.

Evaluation

Class Participation:	30%
Final project:	70%

In-class presentations and discussion of weekly reading will examine the following twelve topics to define new potentials for architecture and expand our understanding of what we are doing when we design:

Week 1
Form and Scale

Neuroscientist: The scales studied in neuroscience across time and size will be outlined as an introduction to the course: Gene – Protein – Synapse – Neuron – Circuit - Behavior
Architect: Ray and Charles Eames iconic 1977's film 'Powers of Ten' will be a starting point for discussion on how advances in scientific knowledge in the intervening 40 years expand our understanding of scale and form.

Week 2
Order and Disorder:

Neuroscientist: Order and disorder in brain function - from arrangement of atoms in molecules to firing patterns of neurons - will be illustrated. The role of phase transitions and stochastic models in neuroscience will be discussed.
Architect: What does it mean for design if we consider order and disorder as emergent properties rather than opposite states?

Week 3
Symmetry and Asymmetry:

Neuroscientist: Symmetry and asymmetry will be considered at the molecular level in terms of chirality, the cellular level in terms of cell structure polarity and function and how asymmetry can from the basis of communication as illustrated by chemotaxis and cell migration and the electrochemical gradient underlying the nerve.
Architect: Types of spatial and formal symmetry and asymmetry will be discussed.

Week 4
Membrane/Inside/Outside/Threshold

Neuroscientist: The neuronal membrane is not only a barrier but a dynamic vehicle for transport and communication. Phospholipid bilayer, ion channels, receptors, endo and exocytosis will be discussed.
Architect: What new potentials are available for architecture as building envelopes become responsive, anticipatory and even conscious interfaces for communication?

Week 5
Stimuli, Signal and Noise

Neuroscientist: Stimuli such as light, sound and touch will be discussed through their receptors, sense organs and cortical areas.
Architect: The stimulus-world is where our behavior takes shape. The concept of *umwelt* will be discussed.

Week 6
Reception/Transduction/Perception

Neuroscientist: Sensory cortices: visual, auditory, sensory will be discussed alongside the role of attention in perception with examples of perceptual illusions and pathologies.
Architect: Discussion of perception as an active process of construction and not simply one of passive absorption.

Week 7
Synchrony/Asynchrony/Oscillation/Tuning/Rhythm

Neuroscientist: Be it across milliseconds or days, timing is critical to brain function. Synchrony and asynchrony will be discussed in terms of neuronal firing, neurotransmitter release, spike-timing dependant plasticity and the coding of information. Tuning in the auditory and visual system will be illustrated by hair cells and orientation selectivity respectively. Circadian rhythm, brain waves such as theta wave will be discussed.
Architect: Architectural projects of temporal complexity will be discussed.

Week 8
Integration/Feedback/Feedforward

Neuroscientist: Excitation and inhibition in the brain. Examples of different types of microcircuits in the nervous system will be discussed to illustrate concepts of feedforward, feedback and lateral inhibition. Input-output relationships and gain control. Role of circuity in generating oscillations.
Architect: In what ways do buildings communicate, anticipate and integrate information?

Week 9
Movement/Coordination/Proprioception

Neuroscientist: Successful, coordinated motor control involves making accurate predictions about a dynamic world. The neuromuscular junction, motor cortex, reach to grasp behavior, proprioception, motor control pathologies and prosthetics and embodied cognition will all be discussed.
Architect: Architecture as a means for releasing sensory information over time will be explored.

Week 10
Plasticity

Neuroscientist: Learning and memory are thought to be underpinned synaptic plasticity. Cellular mechanisms of plasticity, types of memory (declarative/non-declarative, flashbulb) and cross modal plasticity will be discussed.
Architect: Plasticity in architecture of 1990's will be surveyed.

Week 11
Mapping/Navigation

Neuroscientist: The brain maps and remembers space and place. How does it do this? Place cells, grid cells and spatial memory will be discussed.
Architect: Discussion of mapping technologies.

Week 12
System/Network

Neuroscientist: Maps and Models. Sectioning. Layers. Morphology. Anatomy
Architect: Discussion of architectural representation of systems and networks.

Bibliography

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Jakob von Uexkull, *A Foray Into The Worlds Of Animals And Men* (Instinctive Behavior C.H. Schiller ed. International Universities Press: 1957)