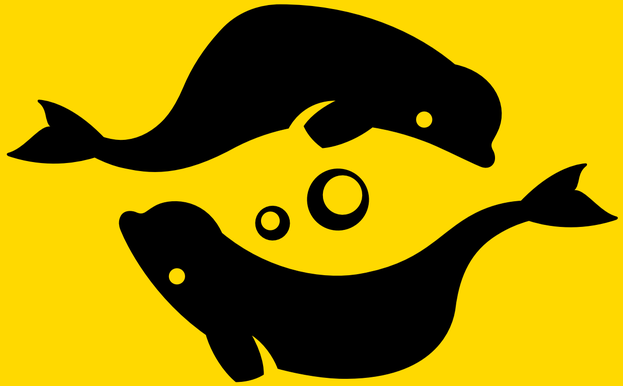

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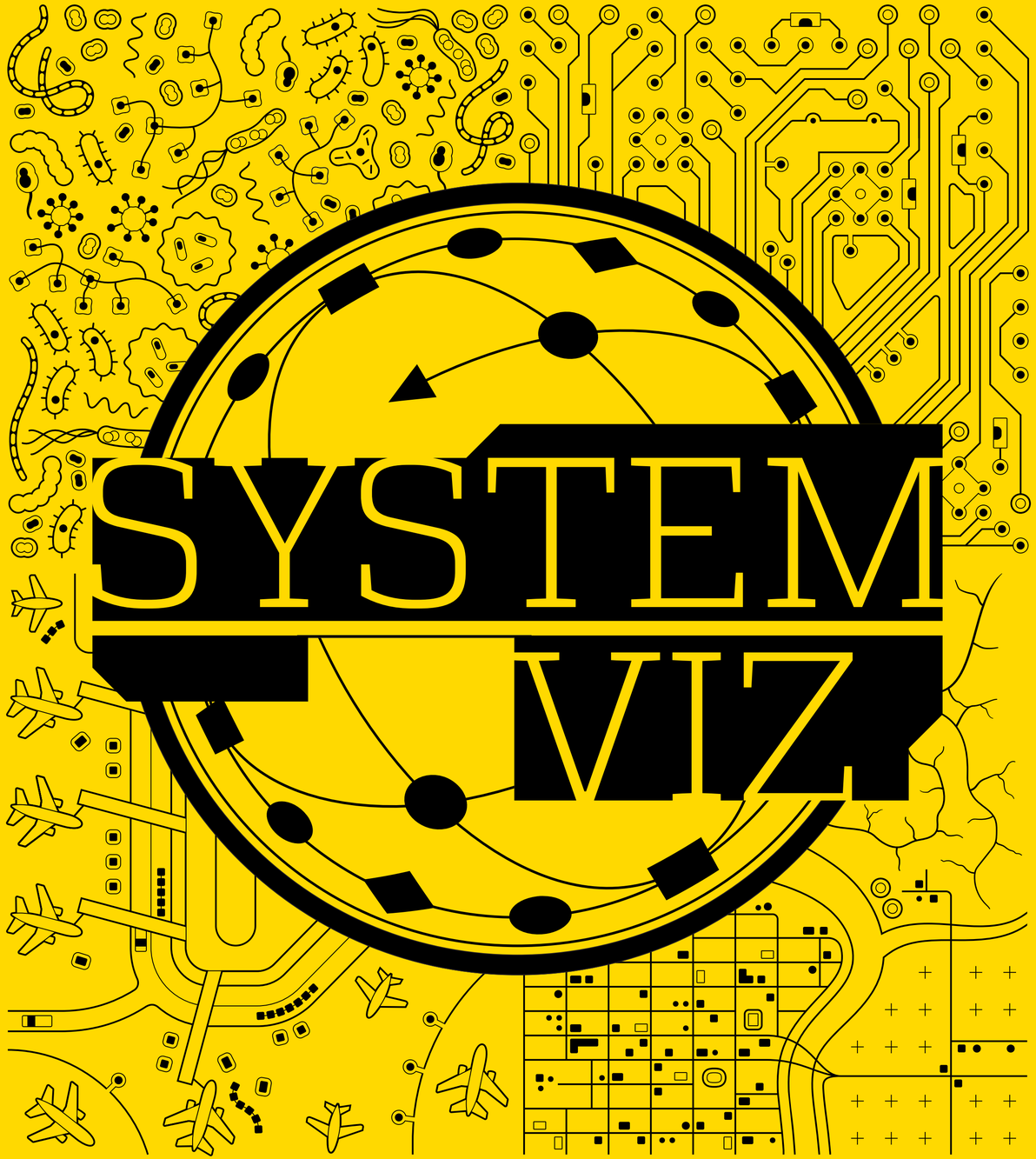
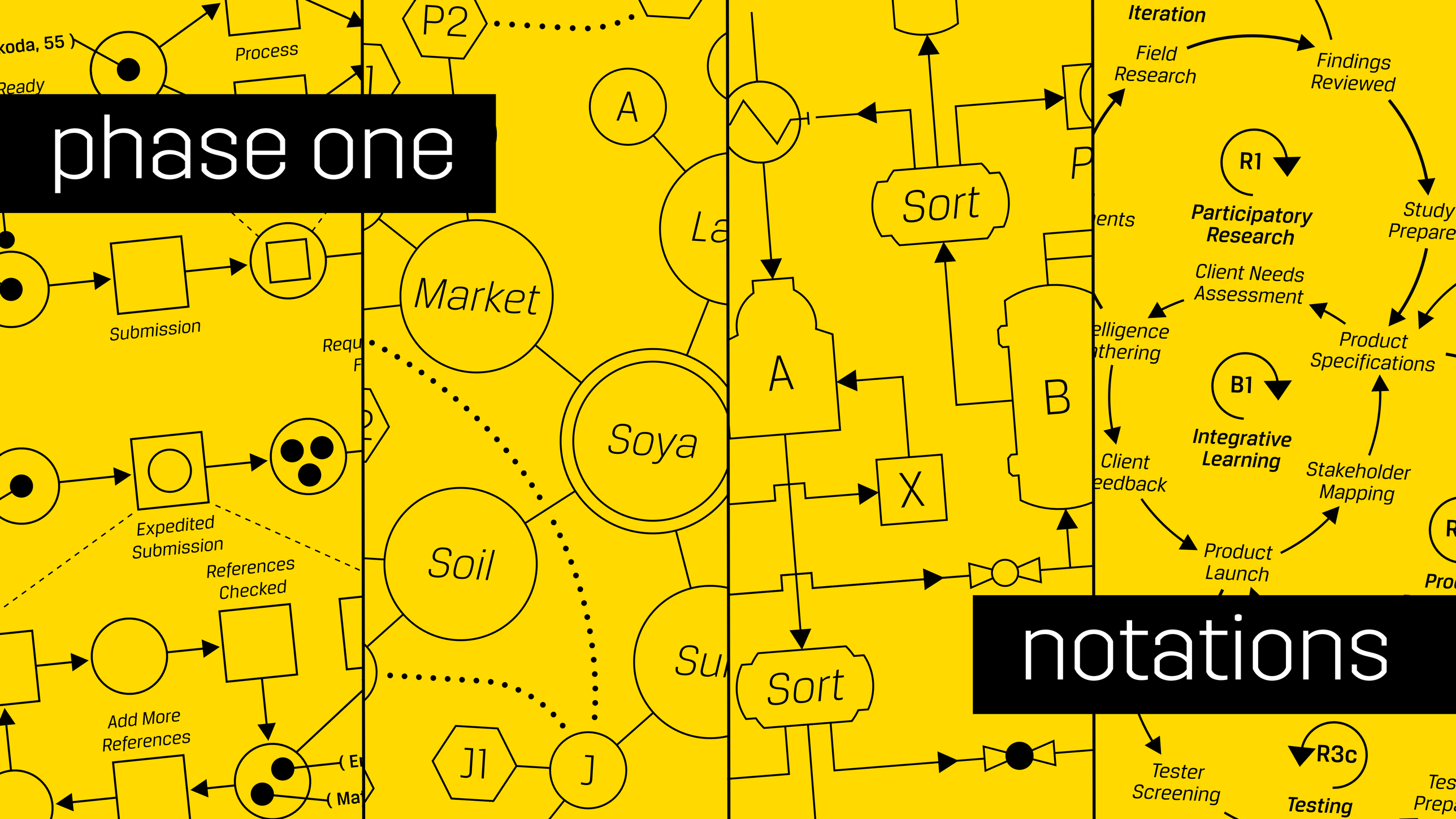


visualizing systems

PETER STOYKO

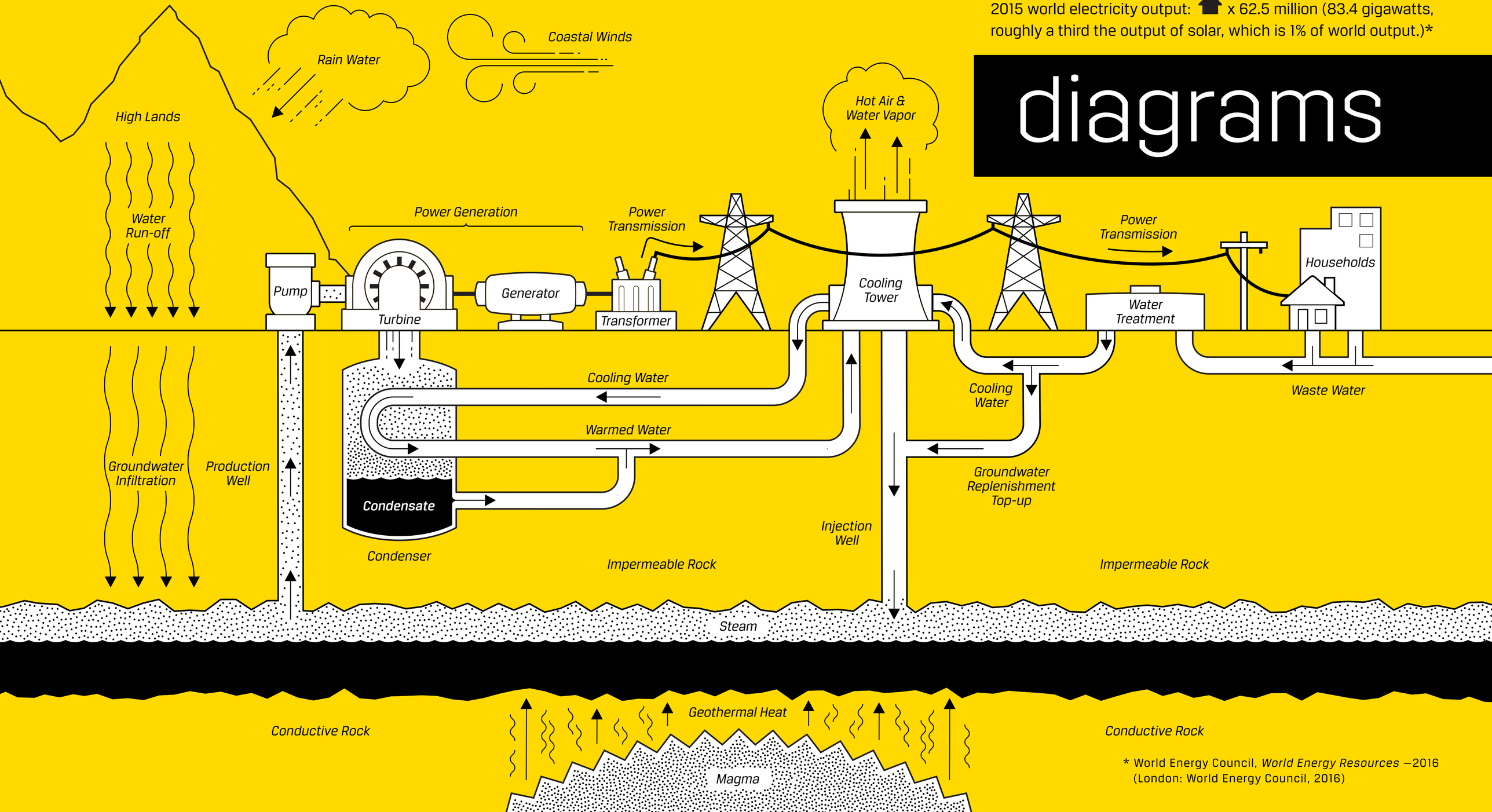
PROJECT OVERVIEW

25 • 10 • 19


phase one
Process
Submission
Expedited Submission
References Checked
Add More References
P2
A
Market
Soya
Soil
J1
J
Sort
A
X
B
Sort
Iteration
Field Research
Findings Reviewed
R1
Participatory Research
Study Prepare
Client Needs Assessment
Product Specifications
B1
Integrative Learning
Stakeholder Mapping
Client Feedback
Product Launch
notations
Tester Screening
R3c
Testing

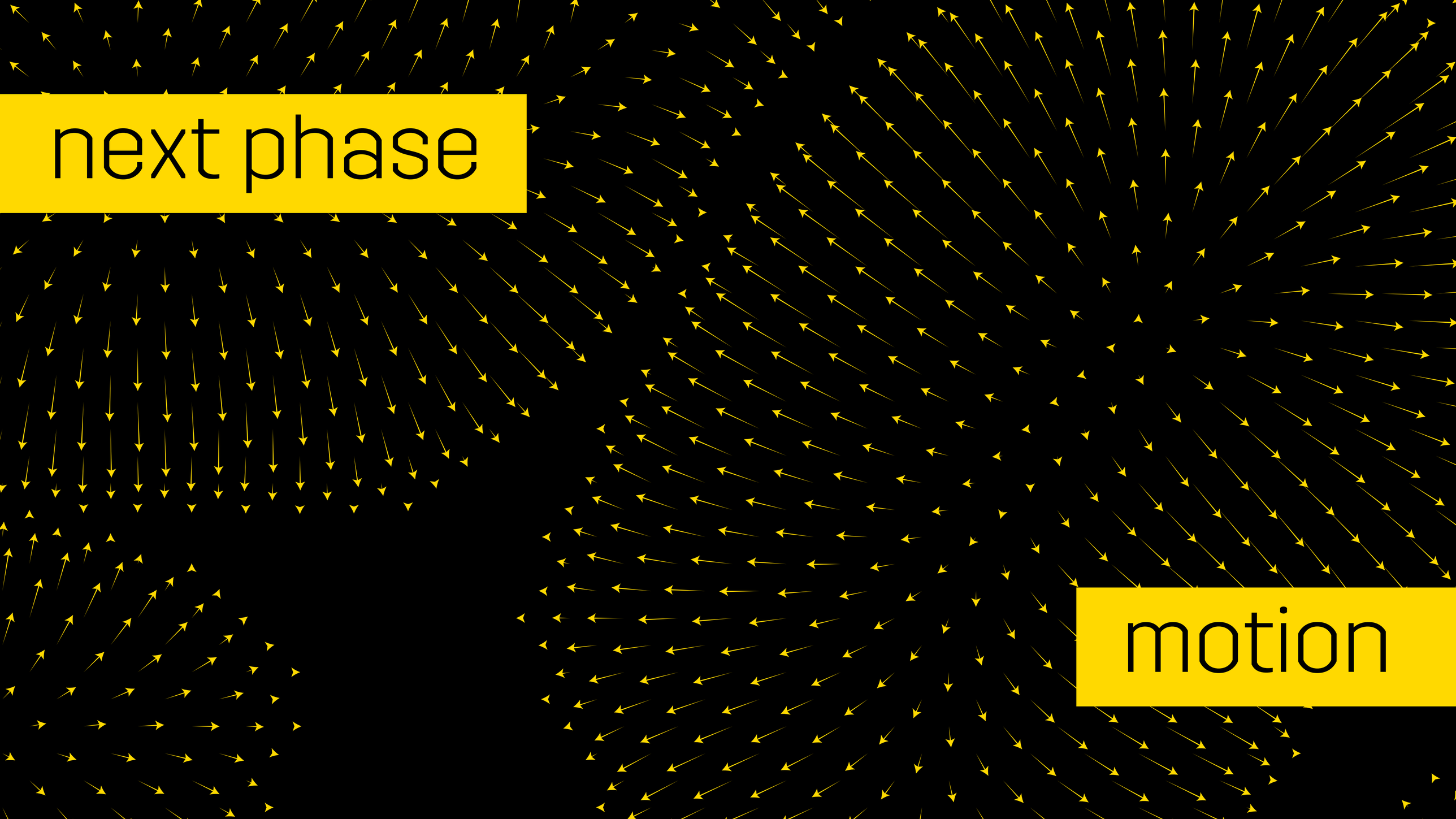
2015 world electricity output: x 62.5 million (83.4 gigawatts, roughly a third the output of solar, which is 1% of world output.)*

diagrams



* World Energy Council, *World Energy Resources* —2016 (London: World Energy Council, 2016)


phase two
visual vocabulary

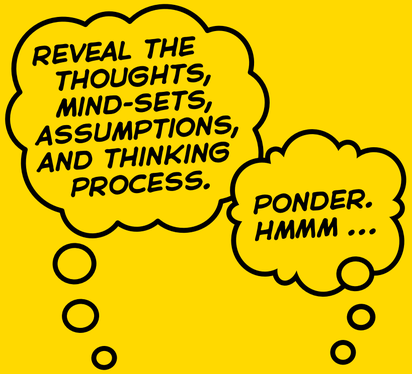

next phase
motion

PRODUCT LINE: PRACTICAL LEARNING TOOLS THAT INVENTORY A SUBJECT AREA

codex

ON

OON

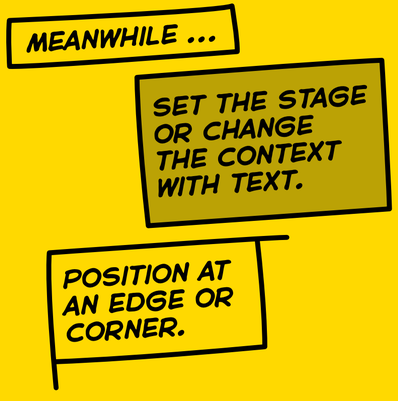


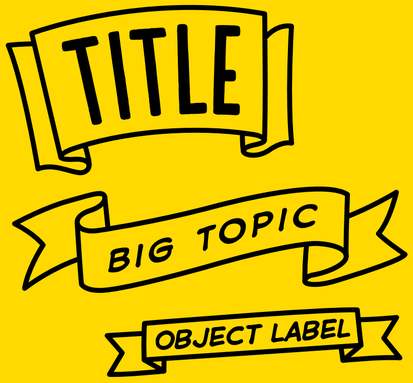
THOUGHT BALLOON

BURST BALLOON

WHISPER BALLOON

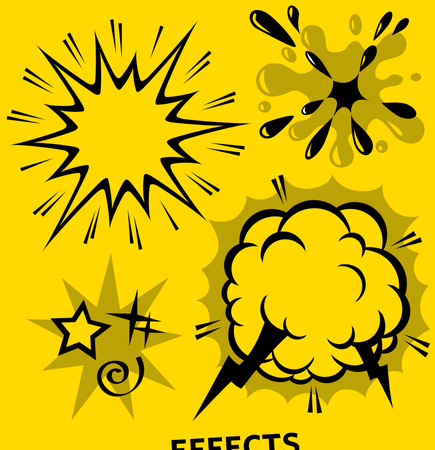
SYMBOLIC CAPTION





BANNER

EFFECTS LETTERING



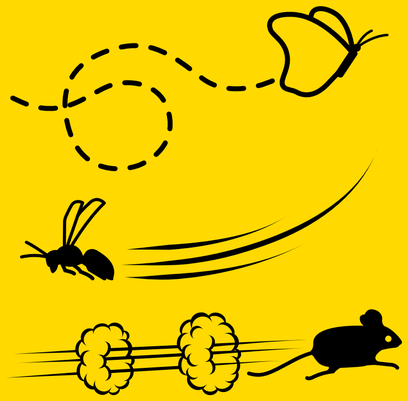
EFFECTS

THEMED LETTERING

MOTION LINE (SHAKE)

MOTION LINE

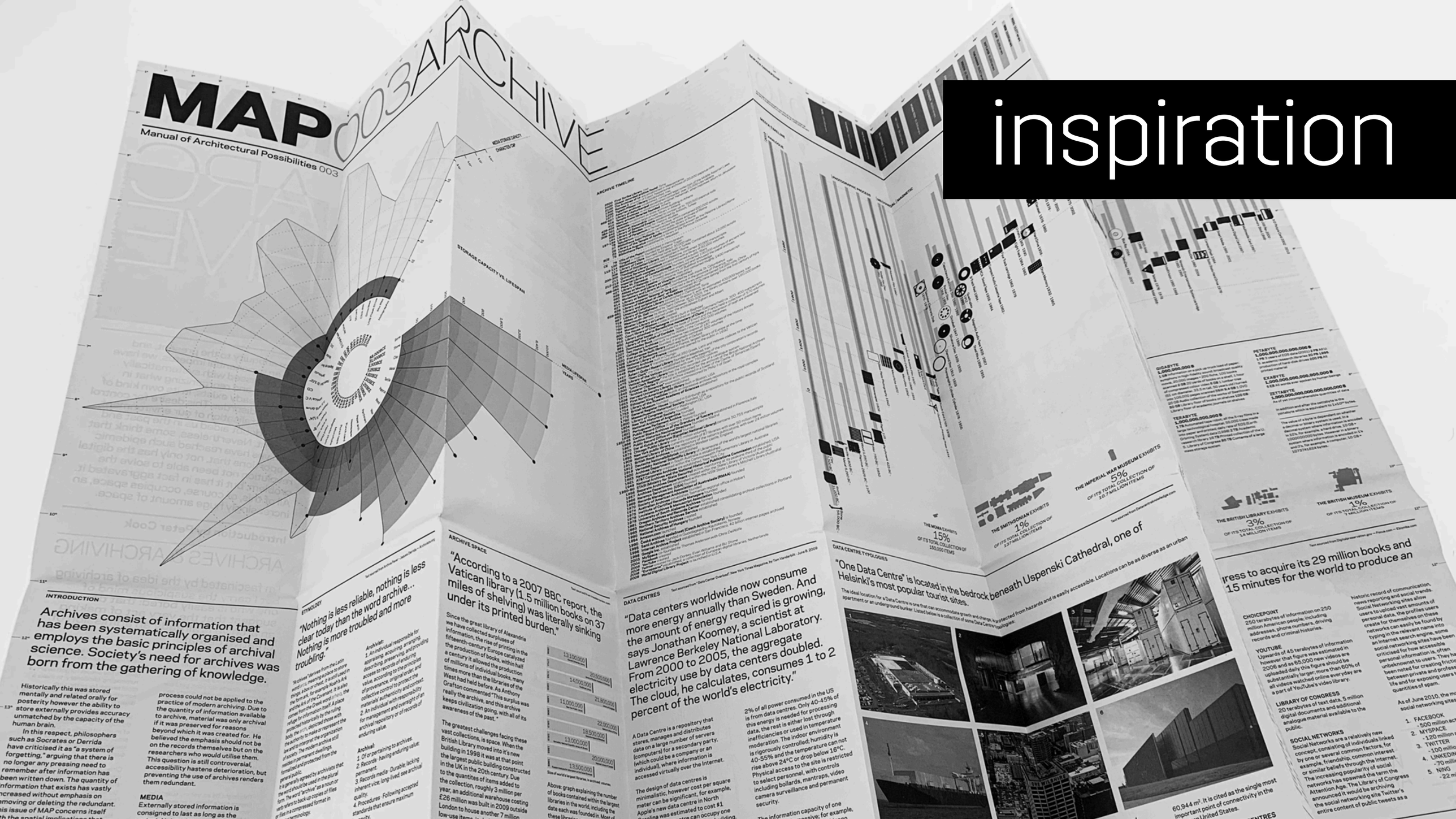
EMANATION LINE



MOTION LINE (TRAIL)

SURFACE LABEL

inspiration



visual vocabulary

SYSTEM TAXONOMY
Six broad categories of system element cut across the various literatures about systems. Any holistic discussion of system should touch on each of them.

TYPES OF SYSTEM
In order to make the large number of system elements more wieldy, they are grouped loosely into three broad types of system.

01 DRIVER
SHAPE :: **SUPERELLIPSE**

A DRIVER IS THE ACTIVE CAUSE OF SOME HAPPENING WITHIN THE SYSTEM. IT CAN ALSO BE THOUGHT OF AS A MOTIVE FORCE, MOVER, FLOW, AGENT, OR ACTANT DEPENDING ON THE SYSTEM. IN ALL CASES, THERE IS AN ACTOR AND AN ACTION, ALTHOUGH ONE OF THOSE MAY BE SOMEWHAT IMPLICIT.

02 SIGNAL
SHAPE :: **EPITROCHOID**

A SIGNAL IS COMMUNICATION THAT CAN POTENTIALLY TRIGGER SOME ACTION. A SIGNAL CAN TAKE MANY PHYSICAL FORMS: SCENTS, SOUNDS, VISUAL STIMULI, ELECTRICAL PULSES, AND SO FORTH. A TRANSMITTED SIGNAL IS NOT NECESSARILY RECEIVED NOR CORRECTLY INTERPRETED.

03 STATE
SHAPE :: **MOKKOUGATA**

A STATE IS A CONDITION OF A SYSTEM OR OBJECTS WITHIN IT. MODE, PHASE, AND STATUS ARE TERMS OFTEN USED FOR STATES. THE CONDITION MAY BE A STATIC OR DYNAMIC, ALTHOUGH MANY STATES THAT APPEAR "STEADY" CAN MASK A LOT OF UNDERLYING TENSION.

04 BOUNDARY
SHAPE :: **ASTROID**

A BOUNDARY SEPARATES DIFFERENT PARTS OF A SYSTEM. BOUNDARIES CAN BE FIXED OR MOVEABLE, REAL OR IMAGINARY, IMPERVIOUS OR POROUS. THE MAJOR DISTINCTION BETWEEN OPEN AND CLOSED SYSTEMS DEPENDS ON THE EXCLUDING CAPACITY OF THE SYSTEM'S OUTER BOUNDARY (OR EDGE).

05 RELATION
SHAPE :: **OVATE**

A RELATION IS THE DYNAMIC BETWEEN TWO OR MORE OBJECTS (OR TYPE OF OBJECT) IN A SYSTEM. A RELATION MAY BE SHORT-LIVED INTERACTION OR AN ONGOING SERIES OF INTERACTIONS. THE PATTERNS OF INTERACTION ARE WHAT MAKE A SYSTEM PREDICTABLE OVER TIME.

06 DOMAIN
SHAPE :: **HEXAGON**

A DOMAIN IS THE CONTEXT IN WHICH THE SYSTEM (OR PARTS THEREOF) EXISTS. THE PHYSICAL ENVIRONMENT, SETTINGS, OR SURROUNDINGS WILL INFLUENCE HOW OTHERS PARTS OF THE SYSTEM ACT. CONCEPTUAL SPHERES, PARADIGMS, OR EPISTEMES SHAPE CONSTRUALS WITHIN THE SYSTEM.

CODEX
DESIGN + VISUAL THINKING

V. 1.0 BY PETER STOYKO

SIMPLE

ATTRACTOR An object that draws other objects towards itself; a bias in favor of an appealing position, object, or state; the value in a growth pole.

PROXIMATE DRIVER A necessary and sufficient cause that directly affects another variable; a cause that is immediately evident in time and space.

ENABLER A contributory cause; can encourage change (*promoters*), consolidate gains (*reinforcers*) or reduce resistance (*enforcers*).

CYCLE A repeating process or iterative effort towards a goal; an ongoing circulation or recycling of elements within a system; loop.

OPPOSER A factor discouraging or resisting change; a counter-acting or counter-balancing agent; an antibody; an anti-thetical influence.

GENATOR The original impetus or trigger of a sequence of events; an initiating cause or stimulus; a foundational event or seed object.

MOTIVE The underlying motivation of an agent to seek a goal; can be internal (instinct, need) or external (incentive, inducement, persuasion).

REPELLER An object that pushes other objects away from itself; an aversion to an undesirable position, object, or state; a feared danger or harm.

GOAL SEEKING The objective or target of a part of the system or the system itself; even within designed systems, goals may not align perfectly.

AMPLIFIER A combination of factors or process that increases the magnitude of an effect; a source of leverage that boosts energy or power.

ANTICIPATION An expectation or prediction of a future happening; an imagined future or scenario; may itself trigger actions, including self-fulfilling ones.

CONDUIT A path along which actors are expected to move; the medium that connects nodes in a network or process.

CONTROL POINT Contact between a subject and object whereby power or influence can be exerted; a time and place where direction is expected.

FEED-BACK Information about the outputs of an action are routed back as inputs to further action (or inaction).

TRAIL The residual left behind after an action showing what happened; the accumulated effects of past actions showing a pattern.

TRANSMITTER An object that sends out a signal; the encoding of meaning for purposes of communication.

STATUS DISPLAY Regularly updated information about a particular object; an identifier for verification; an indicator of intent or receptivity.

MONITOR Active scanning of a process or domain to compare with an expected state; the detection of anomolies; focality of attention.

RECEPTIVITY Selectively attending to signals based on the their compliance with protocols or possession of qualities needed for interpretation.

INSTRUCTION Algorithms that determine how an agent acts and interacts; programmed decision- and learning procedures; encodings.

THROUGH-PUTTING The transmission of signals through a chain, with the potential for the signal to change at each juncture; serial signaling.

RECEPTOR An object that receives a signal, often ignoring or filtering irrelevant signals; the decoding and interpretation of signals.

SIGNS Physical or virtual annotations in the environment; information found in context to guide action.

DECAY The declining usefulness of information and data over time; the weakening of signal caused by distance and impediments.

CUE A signal about the appropriate timing to begin or end a process or activity; a timing marker to coordinate activities.

STOCK A discrete collection of consumable or expendable resources for future use; storage or pooling of materials.

CAPACITY The finite ability to handle a particular quantity of activity or items; the optimal volume(s) at which a function operates.

LOAD A stock of items being moved under containment conditions; the controlled transportation or distribution of objects.

REDUNDANCY Multiple stockpiles or parallel sub-systems that act as a back-up, fail-safe, or extended capacity.

ASSEMBLY Building blocks with which system structures are formed expediently but with integrity; the materials and componentry of a system.

ORDERING Putting items into a formal arrangement that serves system requirements; sequencing or prioritizing items in a process.

TRANSITION Changing from one state to another, often depicted as phases or stages of change; the process of developing a new attribute.

STANDARD A set of items made more or less uniform; conformity to a set of basic criteria of acceptability; interchangeable commodities.

(RE)DISTRIBUTION The dissemination or circulation of resources throughout a system, including the reallocation of stocks at a future moment.

(DE)ACTIVATION The transition from passive object to active entity, or visa versa; emerging from, or dissending into, a dormant state.

ROLE The performative function an actor adopts in the moment to complete responsibilities or tasks; division of labor.

RESET Returning to original conditions or earlier state; reboot or redo that restores default settings or recalibrates using new data.

CONTAINER A boundary that groups and isolates objects; the restriction of movement to a confined space or domain.

SEMI-PERMIABLE A barrier that blocks some objects or substances while allowing others to pass through; a filter.

GATE A controlled opening in a barrier; a barrier opening that allows passage of objects that meet certain criteria.

PROTECTOR A barrier preventing damage to an object by blocking or reflecting unwanted forces.

GAP Spatial separation of objects; a discontinuity in a conduit; the distance that prevents mutual exposure of agents.

TERRITORY The boundaries between control structures; the demarkation of spatial area with a particular meaning or symbolic significance.

DIVIDER A boundary that keeps two or more distinct objects or concepts apart from each other; a hard distinction or separation.

BARRIER A boundary that prevents objects or substances from passing through from one domain to another; a defended front or border.

PATH CONSTRAINT A barrier that limits the flow or trajectory of agents; the contained channeling of substances within certain parameters.

NOTIONAL BOUNDARY A conceptual boundary or delineation; can be tangible in its effects; includes useful distinctions and mental categories.

EDGE Outer boundary that defines the scope of domain or system; an isolating barrier of a closed system or an open-system demarcation.

BRIDGE A passage over or across one or more boundaries; a connection between different domains separated by boundaries.

CLUSTER Elements defined as a group by virtue of proximity and coexistence; a neighbourhood or conglomeration.

GROUP An affiliated collective of actors that share patterns of behaviour or thinking; a collective acting according to a shared logic (herd).

DOMINATION The continual exertion of power and control over a set of objects or actors; overwhelming power across part of domain or system.

DIFFERENTIATION A contrast between other items or actors in a system; establishing a productive niche; progressive speciation.

INTERSECTION The point of contact between two entities; the cross-roads at which actors, forces, or ideas coincide.

COORDINATION The orchestration of actors in the execution of tasks and processes, either through self-organization or management.

MUTUALISM A relationship whereby both parties benefit; reciprocity, or beneficial cooperation; a relationship characterized by positive-sum gains.

RANK The hierarchical status bestowed on an object or actor; vertical ordination based on criterion deemed salient to system operation.

COMPATIBILITY Capable of useful connection or transfer between two parts of a system; a functional interface; interoperability.

SET The complete collection of components for a functional assembly; a group of objects necessary for an organizational unit.

COMMENSALISM An arrangement in which one party is dependent upon another but that dependence is neither harmful nor helpful.

HOMOPHILY The self-sorting of actors into homogeneous groups; the tendency of like-actors to affliate with like-actors over time.

PERIPHERY Existing on or near the outer edges of a space, boundary, group, or field of activity; the hinterland of a domain; an area of relative neglect.

FRICTION A source of passive resistance that hinders activity within a domain; a mild drain of energy becaue of effort needed to overcome.

REFERENCE POINTS Features in the context that can act as orienting devices, including markers (features singled out for special consideration).

RESOURCES The availability and access to the factor inputs needed for a process; sustainable and predictable supply of assets.

SYMBOLIC MILIEU Widely shared and observed symbolic meanings required for interpretation; prevailing linquistic conventions for sense-making in a domain.

CENTRALITY The hub around which activity concentrates; the concentration of power or control within a core of activity.

OBSTACLE An discrete impediment to be overcome or obstruction to be circumvened in order to proceed.

ZONE An area or place amenable to, or specifically devoted to, a purpose; a context with a special functional quality.

SUPPORT STRUCTURE Constructed supports (including underlying or hidden *infrastructure*) that enables activity.

DESERT A space in which resources have been depleted or are scarce to begin with; harsh environment for production or activity.

COMPLICATED

LAG A time delay or perceived delay between cause and effect that has implications for system behavior; looseness of timing.

OUTLIER An atypical case that a system has to handle; a rare *edge case*; an improbable occurance or condition.

BRANCHING The divergent path of an agent or process; a *bifurcation point* can be controlled or very unstable depending on the type of system.

DISRUPTOR A factor causing a major system change or breakage, either internal contradiction or external intruder (*antigen* or *exogenous shock*).

INFLECTION A turning point or critical juncture; a change in direction caused by circumstance or a shift in priorities; a pivot.

SIDE EFFECT Incidental results of an action, often unanticipated; an *externality*, with benefits or harms not accruing to the causal agent.

KLUDGE A work-around or coping strategy used to overcome blockages; a temporary or makeshift augmentation that endures over time.

WAVE Unevenness (surge or flux) in activity occuring within a system; the build-up of factors acting in concert or with similar timing.

PARALLELISM Concurrent processes that complement each other; the division of tasks into sub-tasks that are handled simultaneously.

EQUIFINALITY Multiple activities lead to the same outcome because of a system dynamic or arrangement of constraints.

INTERFERENCE Signals competing for attention; confusion caused by mixed or conflated signals; potentially harmful dis- and misinformation.

EXCHANGE Communicative interaction between two agents, including the rituals and negotation of the terms of engagement.

NOISE Meaningless observations that distract, making detection of useful signal difficult; false signals that can potentially overwhelm.

FEED-FORWARD Information about an impending action is sent out ahead of time to cause a response.

META-MEANING Inferences derived from a set of signals about more general patterns; big-picture patterns that affect system activity.

ALERT A warning signal intended to mobilize a response; an attention grabbing notification caused by an input; a defensive signal.

INDICATOR Indirect or partial signal of status; a symptom of a deeper cause; a summary of the status or actions of a set of items.

ECHO Inadvertant signal generated by actions; residual signs of presence and activity that get transmitted; data exhaust.

CO-PROCESSING Processing of signals and encodings across several interpreters; joint deliberation; collective interpretation norms and conventions.

EROSION The decay of an object due to repeat exposure to actants; degredation of system parts due to wear and tear.

STANDBY Capacity held in reserve until it is needed, often as a back-up or in case of surging demand; readiness for emergencies.

FAULT A malfunction or error that impedes system activities or causes general failure; often unnoticed or creates symptoms elsewhere.

DIVERSITY WITHIN Differences within a particular category of object; variation of shared attributes within an otherwise like group.

FAULT RECOVERY Correction or compensation that minimize impact of faults on a system after the fact; the activation of work-arounds and fail-safes.

PHASE SPACE All the possible states of a system given its many variables; possibility space; each point can be thought of as a system *microstate*.

MULTI-FUNCTION The ability to perform more than one type of task and make judgements about task suitability; contrast with unitasking function.

MAINTAINANCE The restoration of operations after a malfunction; ongoing preservation activities to retain functionality.

FAULT DETECTION Self-diagnosis, self-monitoring, and system-problem identification; detection, prognosis, diagnosis of problems.

DIVERSITY BETWEEN Differences between categories of object; the categorical distinctions reflect a variation in kind or fundamental property.

SCALABILITY The ability to expand capacity; the construction of increased ability to handle volume of processing or traffic.

BUFFER A boundary or zone that diminishes, delays, or otherwise alters a driver or its impact while passing through.

REACTIVE BOUNDARY A boundary that responds to forces and acts as an actant in its own right; a dynamic boundary.

LAYER The combination of two or more complementary boundaries, each of which may have different functional qualities.

ABSORPTION A barrier that allows passage through at a gradual rate based on a capacity to process or make use of; controlled seepage into.

BOUNDARY MOVEMENT The shifting or negotiation of a fixed boundary; the expanded parameters of an edge.

PERMISSIONS The control of activity within a bounded area; the formal and informal conditions of access to a domain; bounded activity.

BOTTLE-NECK A boundary that limits the passage of objects to a narrow gap; constraints forcing a flow to concentrate at a point or opening.

LEAKAGE The escape or inadvertant release of items from a containment boundary; the gradual seepage of items out of a space or domain.

INTERCHANGE A place along a boundary for the two-way movement of traffic; the connection point between conduits that can be traversed.

DIRECTED BOUNDARY A boundary that functions differently depending on what side is facing; boundary sides with different qualities.

COMPARTMENT Some dynamics within a system are contained in sub-systems or modules, with constrained dynamics across modules.

COMPETITION Striving in self-interested pursuit of a goal shared by rivals; attempts to best others by acquiring power, status, or resources.

PROPINQUITY The process by which affiliated actors become more alike over time; the homogenization produced by conformity processes.

TRADE The exchange of something for something else under particular terms, often through a third medium of exchange.

INTEGRATION Connecting systems or parts thereof in order to interoperate; translation layers between sub-systems; incorporators.

COMPLEMENTARITY Different actors or objects are able to do more together than they would otherwise; synergistic or positive-sum bonds.

INTER-MEDIATION A go-between two or more actors or processes that serves a function; a mechanism of translation, matching, or brokering.

AGGREGATE A group of objects or actors of the same type based on characteristics relevant to the system; taxonomy or folksonomy.

MIMICRY A situation whereby one actor copies or simulates the behaviour of another; using one type of system as inspiration for another.

NETWORK An arrangement of inter-connected parts that interact directly through common linkages; the constellation of connections.

COUPLING The tightness or looseness of ties between parts of a system; the *degrees of freedom* of a particular actor in a relationship.

MEDIATION The mitigation or reconciliation of conflict between parties; adjudicate, referee, or resolve tensions in a legitimate fashion.

ALIGNMENT Disparate agents or activities given a common or complementary direction but not necessarily full coordination.

SYNCHRONY The coordination of activities in space and time; patterns of activity that coincide at particular moments.

LEVELS OF SCALE System attributes at different orders of analysis and abstraction; different levels of detail from zooming in and out.

DENSITY The relative proximity of system elements to each other; the size of *interstices*; the concentration of objects and activity.

DOMAIN OVERLAP The existance of more than one domain or partial domain within the same physical or virtual space; nondiscreteness.

SCOPE The mechanisms by which a system is able to expand or proliferate; the extension of a systems edges.

AMBIENT CONDITIONS The continually changing physical environment or cultural milieu with the potential to affect system operations.

CROWDING OUT When the prevalence of on item or activity drives out others; a group occupation of finite space that fills capacity.

STRATA Levels of activity and location that overlap and underlie, including hidden layers; sub- and super-strates of a system.

NESTING Embedded subsystems or systems inside systems which influence each other but are not necessarily fully integrated.

TRAFFIC The volume of activity flowing through a system; the constraint caused by the congestion of activity within a domain.

AUTO-ENVIRONMENT An context that responds to presence and configures to requirements; a context with controlled conditions; climate control.

TOPOLOGY The variable contours of an environment or space; an x-scape, with "x" being a physical-spatial or symbolic-spatial variable.

FALLOW Recovering from use by setting aside or curbing use for an interval; reaccumulation of depleted resources; restoration.

COMPLEX

DISTAL DRIVER An indirect, ultimate cause of a changing variable; a "big picture" cause that is evident at a high level of abstraction.

CASCADE A sequence of knock-on effects; a chain reaction; a succession of second-order, third-order (and so on) effects.

GOAL DRIFT Evolving objectives or targets, including losing sight of *raison d'être*; an ongoing shift in priorities affecting system activities.

DIFFUSION A multiplacative effect or diffuse spread; a ripple- or viral effect; the widespread distribution of an element throughout a system.

AGGREGATE AGENT A collection of agents take on the characteristics of a singular agent; agent-like behaviour of collectives at higher levels of analysis.

CONFOUND An unexpected, unwelcome factor persisting in a system; a free radical or ghost in the system; unplanned-for case causing difficulties.

MULTIFINALITY Acting upon an object may produce different outcomes depending on the state of the system or contextual factors.

PERSPECTIVE The vantage point and field of view by which system (or parts thereof) is perceived; accumulated experiences affecting interpretation.

FRAMING Interpretive paradigm which makes the system understandable; language and mental models that guide sensing and interpretation.

SITUATED MEANING Signals that require contextual cues to be fully interpreted; the meaning given to something in the moment or circumstance.

EQUILIBRIUM The balance or steady state created by opposing forces; the axis around which such a balance is maintained.

EMERGENT PROPERTY A characteristic or function that comes into being without direction; multiple objects have qualities the parts alone do not have.

COMBINATION The synthesis of two or more objects or substances; bringing together the capabilities of multiple agents.

SELF-SIMILARITY Objects or sub-systems that resemble themselves at different levels of analysis; fractal patterning

CRITICALITY The threshold beyond which a dynamic becomes self-sustaining; critical mass necessary for an activity to take place.

MUTATION A reconfiguration of an object caused by an error or exogenous factor, usually noticed when bestowing an advantage or disadvantage.

SEPARATION The division of a part into two or more parts; the extraction of constituative elements from a mixture.

REPLICATION When an object is copied, reproduced, or divided into two or more analogous objects.

TIPPING POINT The threshold beyond which rapid, large-scale change happens; the dynamic unleashed by a sudden force imbalance.

FUZZY BOUNDARY A boundary with edges that are hard to detect or are otherwise ambiguous; a boundary with inexact demarcation.

CONTAMINATION An unintended mixture of items; the taint of an outside object or agent across a containment boundary.

OPACITY Extent to which sensing through boundaries is possible; a matter of degree of openness, transparency, or hiddenness

LIMINALITY Moving into the space between domain boundaries; the reorientation that comes from travelling across domains.

FLEXIBLE BOUNDARY A boundary that changes configuration in response to conditions; a boundary that is not in a fixed shape, configuration, or position.

BREAKDOWN The failure of a boundary to function as designed; the damaging of a boundary by a force; the desolution of a boundary between domains.

CROSS-POLLINATION Aspects of two or more objects are combined to create a hybrid; the purposeful breeding of a new type of entity.

ADJACENCY Parts (or potential parts) that are near or adjoining; nearby opportunities or risks; a proximate or related niche.

PARASITISM A relationship in which one party is harmed or destroyed while the harming party benefits or is unaffected; amensalism.

HOLON When the whole of the system is replicated within the parts of the system, usually as a means for the system to propagate.

PREDATION Attacking or plundering of of one entity by another or by a process; the use of another actor as consumable resource.

SYMMATHESY Simultaneous contextual learning or influence between entities through mutual exposure.

GOAL SHAPING The way an environment influences the goals of actors within; context-derived needs, wants, motivations, and objectives.

CIRCUMSTANCE The conflation of contextual factors at a time and place affecting system activities; exigencies to be dealt with in the moment.

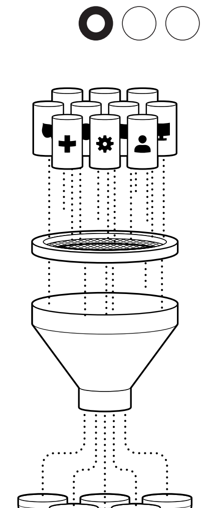
ENTROPY The existance of disorder or chaos in a system; sources of disarray within a system and the extent to which they hold sway.

UNCERTAINTY Aspects of a domain that remain unknown or poorly known; outstanding questions to be resolved about an aspect of the system.

CONDITION SHOCK Circumstances at the edge or beyond what system can ordinarily cope with; major temporary contextual stressor.

CRUFT The build up of additions, patches, and work-arounds, many of which out-live an original purpose; legacy parts or sub-routines.

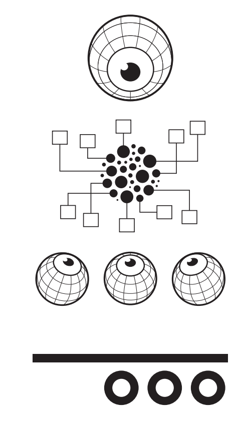
from silos to buckets



The idea of a general theory of systems has gone in and out of fashion over the last century. The pendulum has swung away because of the narrowing of academic and professional disciplines. We now have many specialized vocabularies for describing systems. Indeed, the very notion of what a system is has fragmented. This development runs counter to a core premise of systems thinking: the world is understandable only insofar as we see how parts relate to wholes. How far can we get if only a thin sliver of the whole is considered at once? Even if a unified general theory is unrealistic, the value of an ongoing conversation across disciplinary silos is clear. Yet without common points of reference, how can such a conversation take place?

This inventory offers common points of reference in the spirit of visual-vocabulary building. The inventory began by looking at *system* as a genre across disciplinary literatures; that is, as a set of persistent features over time and across contexts (Siskin, 2017). Everything from mechanical control systems to natural ecosystems has been taken into account. The various system elements and dynamics were grouped, abstracted into generic classes, and organized into six buckets. Much "lumping" and "splitting" is going on here. Despite best efforts, the inventory is nonexhaustive; there will inevitably be something missing, so this inventory is in no sense "done." The labels and distinctions are ones "in good currency" (Schön, 1970), which may not be the trendiest coinages nor reflect the nuances of every school of thought. But that is very much the point of a common reference.

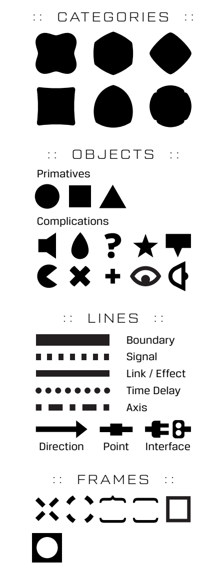
system sight



We learn much about our world by singling out particular patterns for special consideration and assigning labels. We are visual creatures, so we add an archetypal image to that label in our memory—we "dual code" the concept. Without these mental distinctions, we would glance past much of what we see as insignificant noise. That is how a large visual vocabulary makes us more discerning observers.

Systems are a challenge to study because there are so many potential dynamics and organizing principles to keep track of. Moreover, systems operate at many different levels of analysis. Even experienced analysts have a hard time juggling all the relevant patterns in the mind. Now consider the difficulties that a diverse group of co-designers encounters. Members often talk past one another without a common vocabulary. A visual vocabulary in document form—a *codex*—goes even further in stimulating dialogue by offering a handy checklist of things to consider. This checklist is also a useful teaching tool.

design



The inventory icons follow a set of visual tropes and stylistic rules. A trope is a non-literal signifier of something. Many of the tropes used are common to both popular culture and specialist notations. For example, arrows are used for forces, causes, flows, and the like. As another example, brackets are used for sets. The stylistic rules add further consistency across the set. For example, drivers have a different line thickness than boundaries. Plus signals and time delays have different line styles. This design is useful to maintain coherence as others add to, and adapt, the inventory. The icon building blocks are shown to the left (methodological notes available separately).

The design begins with outline shapes for each of the six categories. The contrast between shapes is maximized while maintaining equivalent optical volume so that interior icons appear similarly proportioned. Each category represents a major organizing theme running across the system theory literature. Those who think of systems primarily in terms of "stocks and flows", or "networks and organizing principles," or "signals and boundaries," or "context and perspective" might not find all categories equally useful. That's fine. But users are invited to broaden their conceptual repertoire.

Each interior icon is not a stand-in for the concept but an evocative instantiation. In other words, even though the meaning of each icon may not be entirely self-evident initially, the shapes are somewhat illustrative. This helps make the concepts vivid in the imagination as the definition is understood. Thus, once learned, the set of icons becomes easy to parse; it has "reference value" as the visuals evoke the concept in the mind more efficiently than words.

REFERENCE. Donella H. Meadows, *Thinking in Systems* (White River Junction, VT: Chelsea Green Publishing, 2008); Donald Schön, "Change and Industrial Society," Reith Lectures (London: British Broadcasting Corporation, 1970). Clifford Siskin, *System: The Shaping of Modern Knowledge* (Cambridge: The MIT Press, 2017). Thomas Twaites, *The Toaster Project* (New York, NY: Princeton Architectural Press, 2010). **NOTES.** The distinction between *diversity within* and *diversity between*, as well as its significance for systems theory, are fully explained in Scott E. Page, *Diversity and Complexity* (Princeton, NJ: Princeton University Press, 2011). The concept of *symmathesy* comes from Nora Bateson, *Small Arcs of Larger Circles: Framing Through Other Patterns* (Axminster: Triarchy Press, 2016). The *signals* and *boundaries* distinction, plus the notions of "directed edge" (here called *directed boundary*) and *aggregate agent*, come from John H. Holland, *Signals and Boundaries: Building Blocks for Complex Adaptive Systems* (Cambridge, MA: The MIT Press, 2012). The term "levels of scale" comes from Christopher Alexander's "fifteen fundamental properties of wholeness" (from *The Nature of Order, Book 1*, Berkeley, CA: Center for Environmental Structure) although other aspects of Alexander's list are not drawn directly from that work; "echos", "roughness", and "strong centers" are different from *echos* (narrower in meaning), *friction* (broader), and *centrality* (broader) respectively. The concept of *holon* comes from Arthur Koestler, *The Ghost in the Machine* (New York, NY: Macmillan, 1975). The notion of *assembly* included here is in the spirit of Alexandr Bogdanov's notion of "podbor" as a principle for creating sophistocated organization via a "concordance" of parts, fit together with "expedient integrity." See Simona Poustilnik's "Alexsandr Bogdanov's Tektology: A Science of Construction," in Pia Tikka, *Culture as Organization in Early Soviet Thought* (Helsinki: Aalto University, 2016). PEST analysis is originally attributed to Francis J. Aguilar, *Scanning the Business Environment* (New York: Macmillan, 1967).

systems thinking

"It's all very simple," we're often told about our messy world just before a pat claim is offered. Or a chronic problem is "boiled down" and assigned a three-step "solution" by a well-meaning "fixer." Or a pundit offers a "hot take" that stridently turns initial impressions into a confident read of the situation. All that to say, we habitually turn to reassuring simplifications to guide us in uncertain times, even when that habit has a dismal track record of success.

Thinking in terms of systems can curb that impulse. Indeed, seeing our world as a tangle of crosshatching systems is quite humbling. Even the simple objects that surround us are the product of various systems and subsystems operating behind the scenes. Try tracing the development of that paper-clip on your desk. Can you even fathom the systems that created the metal alloy the clip is made of? And the larger impact of the mining and smelting to the surrounding ecosystem and communities? Thomas Thwaites (2010) famously built a toaster completely from scratch without the benefit of standard manufacturing systems. It took nine months. And that was with help from countless other systems that enabled him to operate in modern society.

Paper-clips and toasters are the product of clearly demarcated and tightly controlled systems. Many of society's difficulties are entangled in far less predictable systems that interact in ways we scarcely understand. The dynamics seem both paradoxical and intractable, perhaps even mysterious. These "wicked problems" are enough to make us throw up our hands in exasperation and settle for short-sighted coping strategies. Not so fast. These are still early days in our attempts to properly *tune our way of seeing* to adequately grasp how systems affect our lives.

This codex starts from the premise that such understandings are possible. However, if you are looking for quick and easy guide, you've come to the wrong place. The main conclusion I draw from the literature on systems—in the natural sciences, the social sciences, the managerial practices, the design disciplines—is that there are a great many common system elements and dynamics to keep track of. It is worth itemizing what these commonalities are and become familiar with their qualities. That is how we tune our gaze. It's a daunting task, to be sure. It's easy to get lost in the details. The hope is that this codex makes that learning a little easier.

Before proceeding, it helps to stipulate what is meant by "system." As Donella Meadow's puts it, "A system is a set of things—people, cells, molecules, or whatever—interconnected in such a way that they produce their own pattern of behavior over time." (Meadows, 2008) She adds that there is a coherent organization to this set, one intended to achieve something (a function or purpose). This codex surveys many schools of thought on the subject, each with their own conceptions. Nonetheless, Meadows definition is a big enough tent to encompass the various theories, schools, and disciplines that talk about systems.

I started by pooh-poohing the crude simplifications we habitually reach for to explain our world. I should clarify one the analytical priorities of this codex. I do not have anything against reductionism, *per se*. Indeed, building bridges across the various disciplines is unavoidably an exercise in distillation to some extent. Yet, too many accounts of systems are frustratingly hand-wavy about what specific mechanisms and dynamics that are at play. It's that vagary that can get in the way of a deep understanding of how everything fits together. An essential part of learning involves singling items out for special attention, assigning clear meanings, and exploring the implications. Knowing a lot about the trees does not necessarily mean losing sight of the forest; actually, it's quite essential to figuring out how the forest works.

visualizing systems

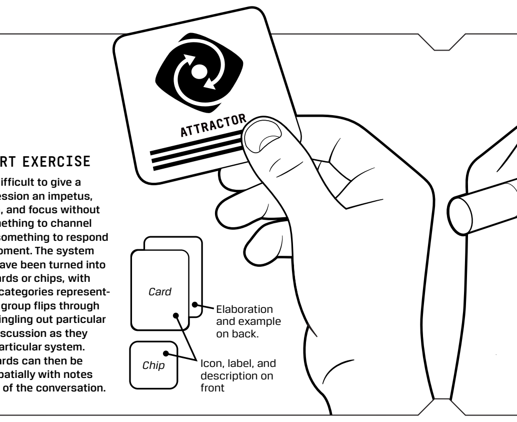
Complex systems are difficult to understand without the aid of visuals. There are too many moving parts to mentally keep track of. The parts interact in too many ways. The whole system is cognitively overwhelming insofar as it cannot be absorbed in one go without the aid of an external reference. That is partly due to humans' inability to juggle more than a few complicated ideas in working memory at one time. Thus, visuals are a simplifying and organizing device that complements the way human naturally think if they are designed well. The SystemViz project explores what it means to design such visuals well.

This codex draws from the interdisciplinary literature on systems to create a visual vocabulary. One larger goal of the project is to compare this inventory of elements to the notations and diagramming techniques for visualizing systems generally. Are there important aspects of system that are poorly captured by these techniques? If so, are there alternative methods of visualization? Each notation and diagraming technique contains its own assumptions about what a system is and what elements are most important. By asking these questions, the hope is to identify blind-spots and create new techniques for better expressing systems thinking.

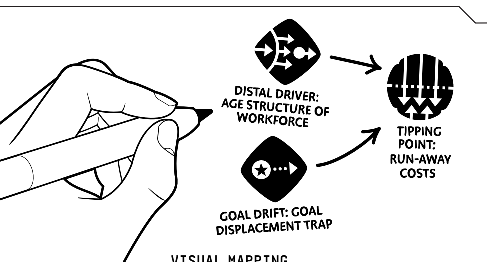
The reverse side of this codex presents an example of the visual vocabulary in action. The point is to provide a detailed example of how the inventory can be used to analyze a realistic design case. The hope is to further clarify the potential usage scenarios discussed below. Perhaps the examples will even inspire others to use the vocabulary to explore other subjects.

usage scenarios

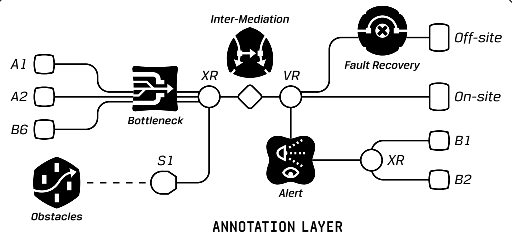
The visual vocabulary has several applications for diverse teams of designers working together through dialogue. Dialogue is an free-form conversation in which everyone can express themselves openly to jointly create something worthwhile. Several activities can jump-start these conversations and help them grapple with the multifaceted systems.



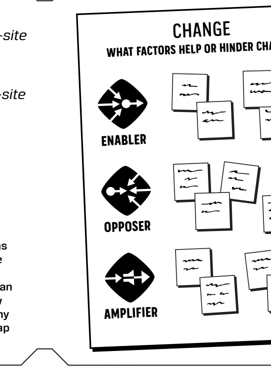
CARD SORT EXERCISE
It is often difficult to give a dialogue session an impetus, momentum, and focus without having something to channel attention; something to respond to in the moment. The system elements have been turned into decks of cards or chips, with the six big categories representing suits. A group flips through the deck, singling out particular cards for discussion as they explore a particular system. Relevant cards can then be arranged spatially with notes as a record of the conversation.



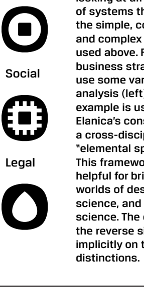
VISUAL MAPPING
A group can explore the various parts of a system visually by charting it out on a large canvas. The various vocabulary items can populate the map to show particularly interesting qualities, functions, and dynamics within the system. The items can also alert designers to parts of the system that would otherwise go overlooked, which can guide research.



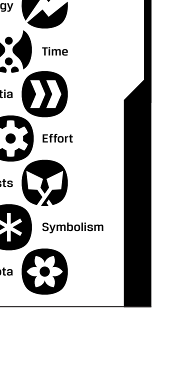
ANNOTATION LAYER
The vocabulary also serves a diagnostic function, as an already visualized system or data display can be further analyzed by matching vocabulary items to parts of the system. This added layer of meaning can shed new light on difficulties or help to explain how a system works on a deeper level. This applies to any visualization, from technical notation to pictoral map to free-style bricolage.



VISUAL TEMPLATE
Brainstorming can revolve around individual vocabulary items or small clusters of items arranged in a poster-sized template. Such a template presents an analytical framework with blank spaces for participants to fill in additional information. Visual arrangements can be simple tables to elaborate charts, with visual vocabulary items anchoring each cell area. Instead of relying on off-the-shelf templates or "canvases," designers can design their own based on the particulars of the project at hand.



TERTIARY ORGANIZING DEVICE
Analysis can benefit by looking at different types of systems that go beyond the simple, complicated, and complex distinction used above. For example, business strategists often use some variant of PEST analysis (left). Another example is used in Elanica's consulting work, a cross-disciplinary set of "elemental spheres" (right). This framework is often helpful for bridging the worlds of design, social science, and organizational science. The example on the reverse side relies implicitly on these distinctions.



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DRAFT
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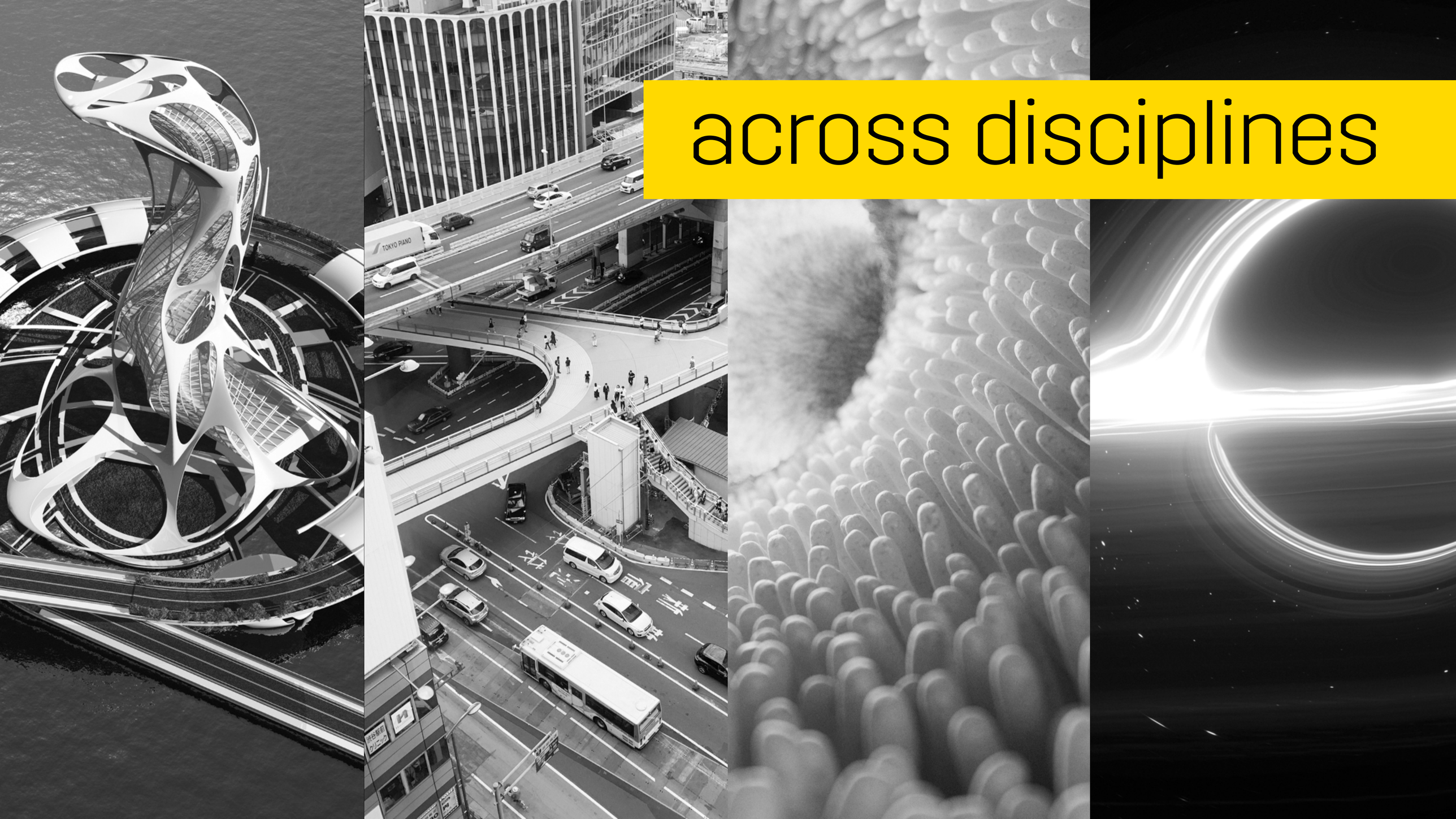
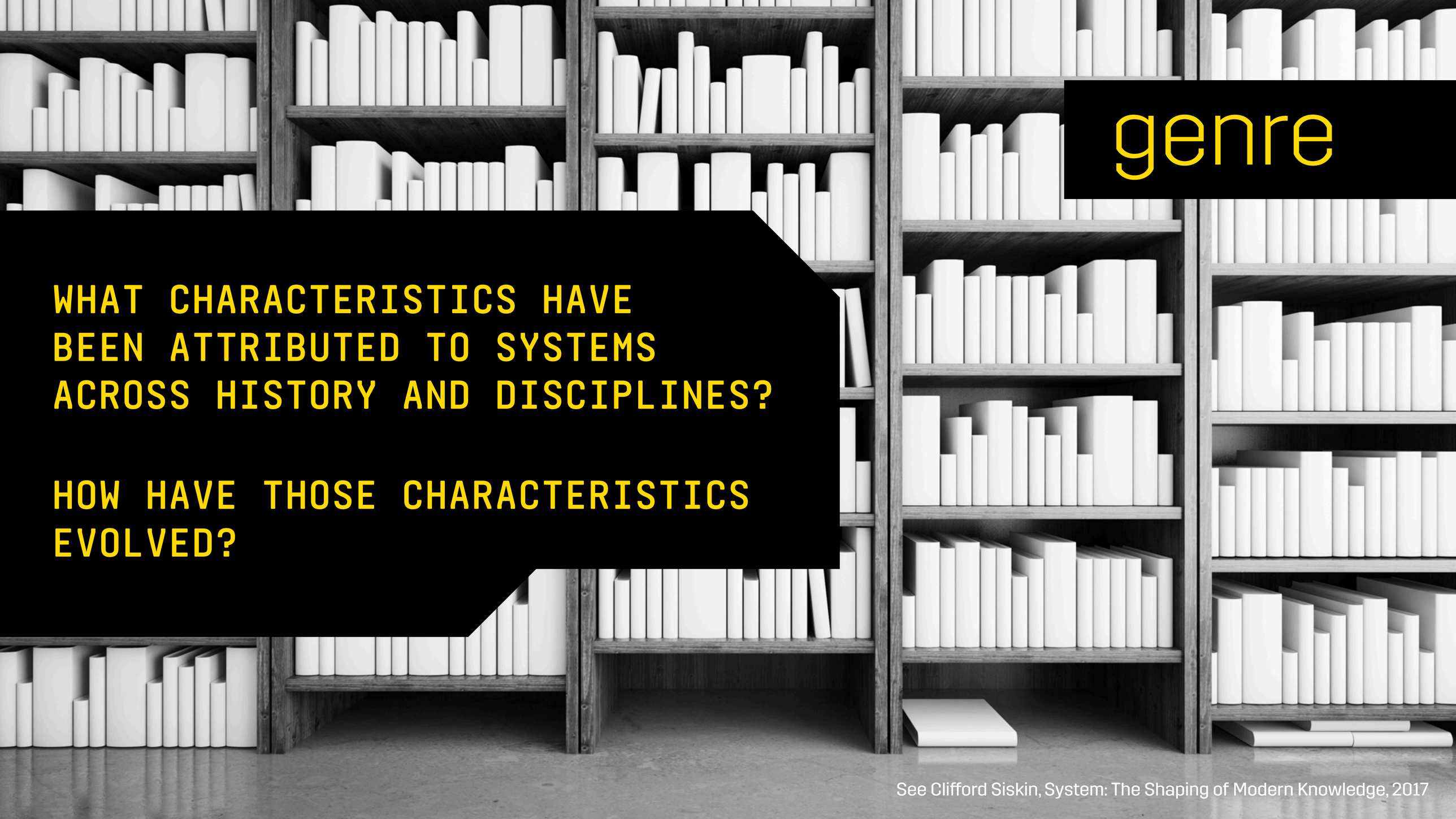
Learn more about the SystemViz project and download materials at
www.systemviz.com


across disciplines



genre

WHAT CHARACTERISTICS HAVE BEEN ATTRIBUTED TO SYSTEMS ACROSS HISTORY AND DISCIPLINES?

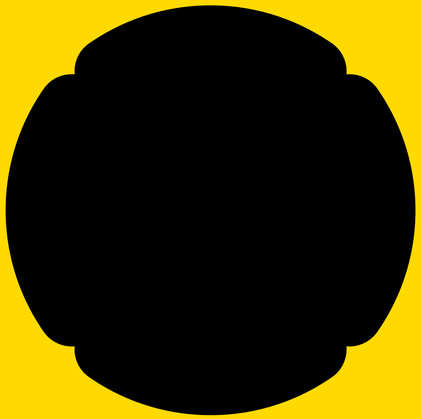
HOW HAVE THOSE CHARACTERISTICS EVOLVED?

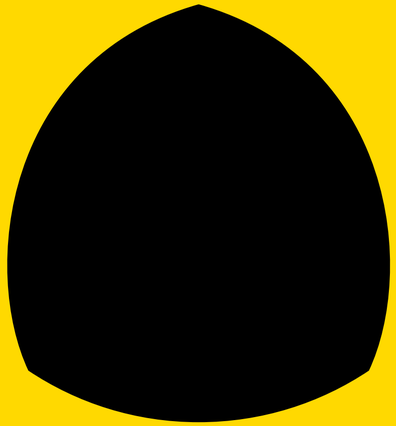
See Clifford Siskin, System: The Shaping of Modern Knowledge, 2017

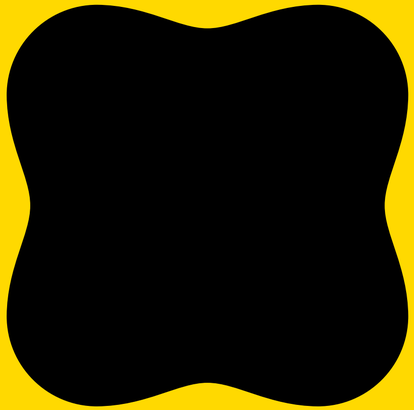
DRIVERS

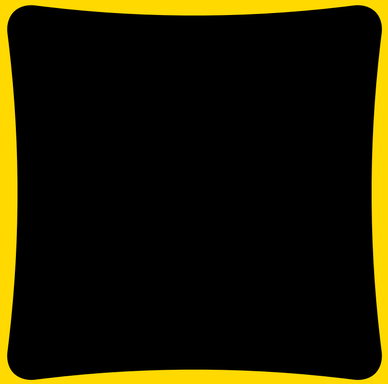
STATE

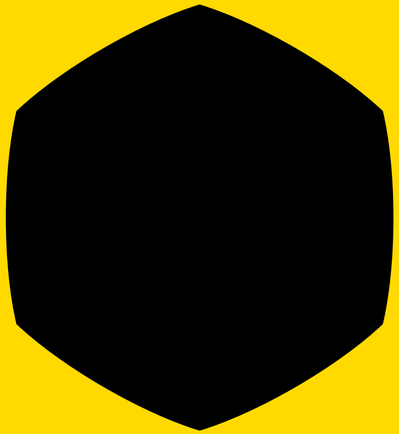
RELATION











SIGNAL

BOUNDARY

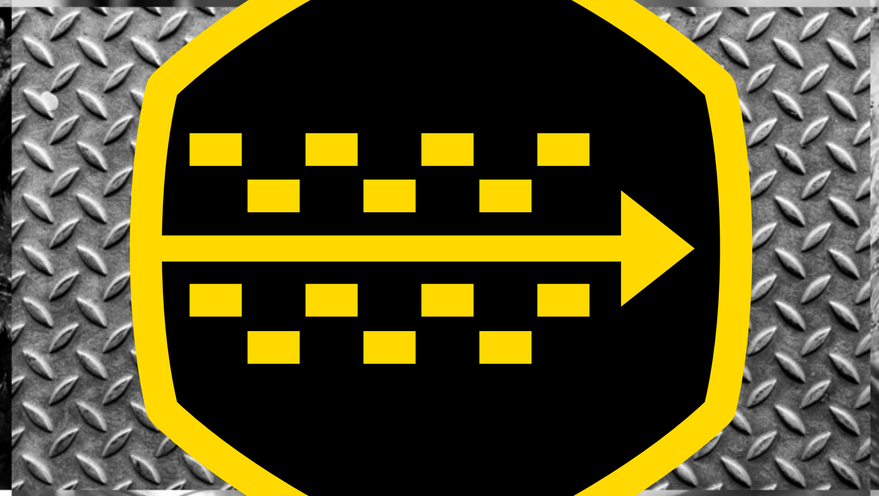
DOMAIN


SALE
SALE
SALE
SALE
SALE


km
34
10
34
14

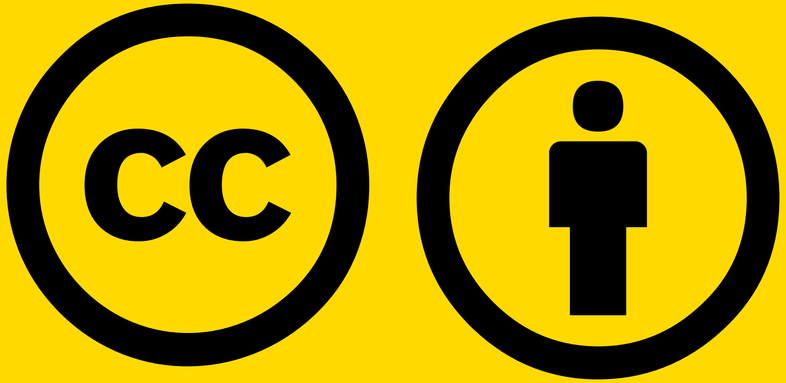








open

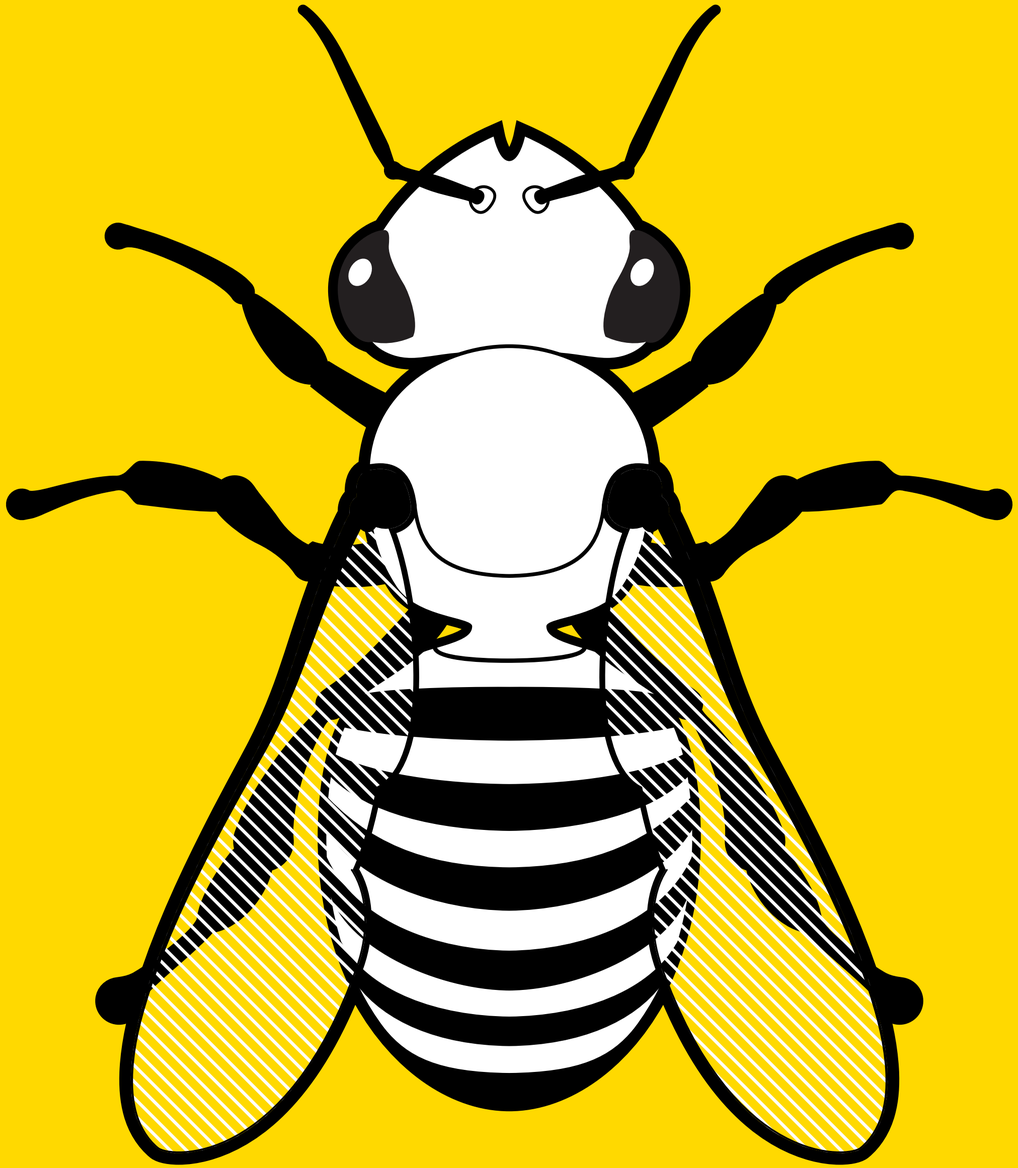


CREATIVE COMMONS
FREE CULTURE LICENSE

FURTHERING THE DISCIPLINE THROUGH SHARING: WHAT CAN OTHERS DO WITH THE CODEX?


NESTING
Embedded subsyste
systems which influ
are not necessarily
EDGE
Outer boundary that defines the scope of
domain or system; an isolatin
closed system or an open-s
DIVERSITY WITHIN
thin a particular category
ation of shared attribute
rwise like group.
REPELLER
An object that pushes other objects away from
ion to an undesirable position,
e; a feared danger or harm.
SYMMATHESY
Simultaneous contextual learning or
influence between entities through
mutual exposure.
SITUATED MEANING
Signals that require contextual cues to be fully
interpreted; the meaning given to something in
the moment or circumstance.

chips

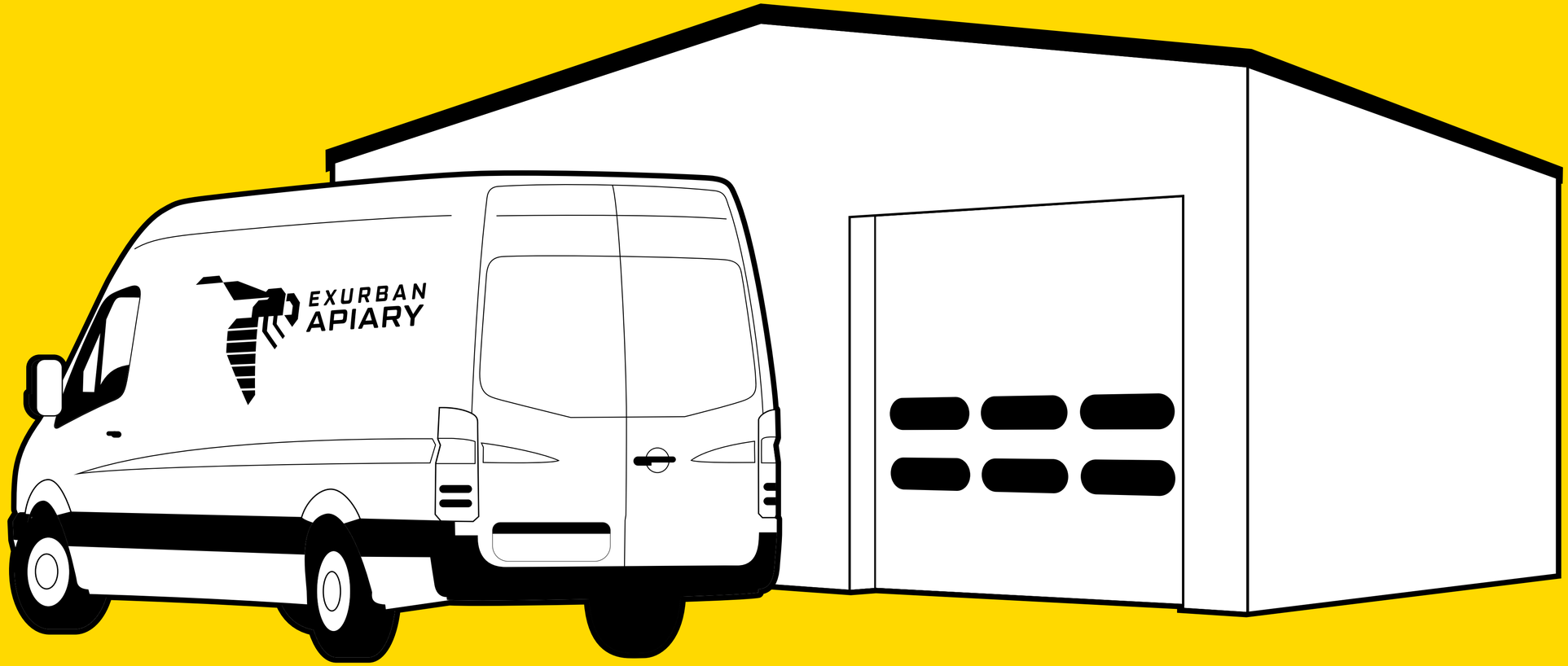


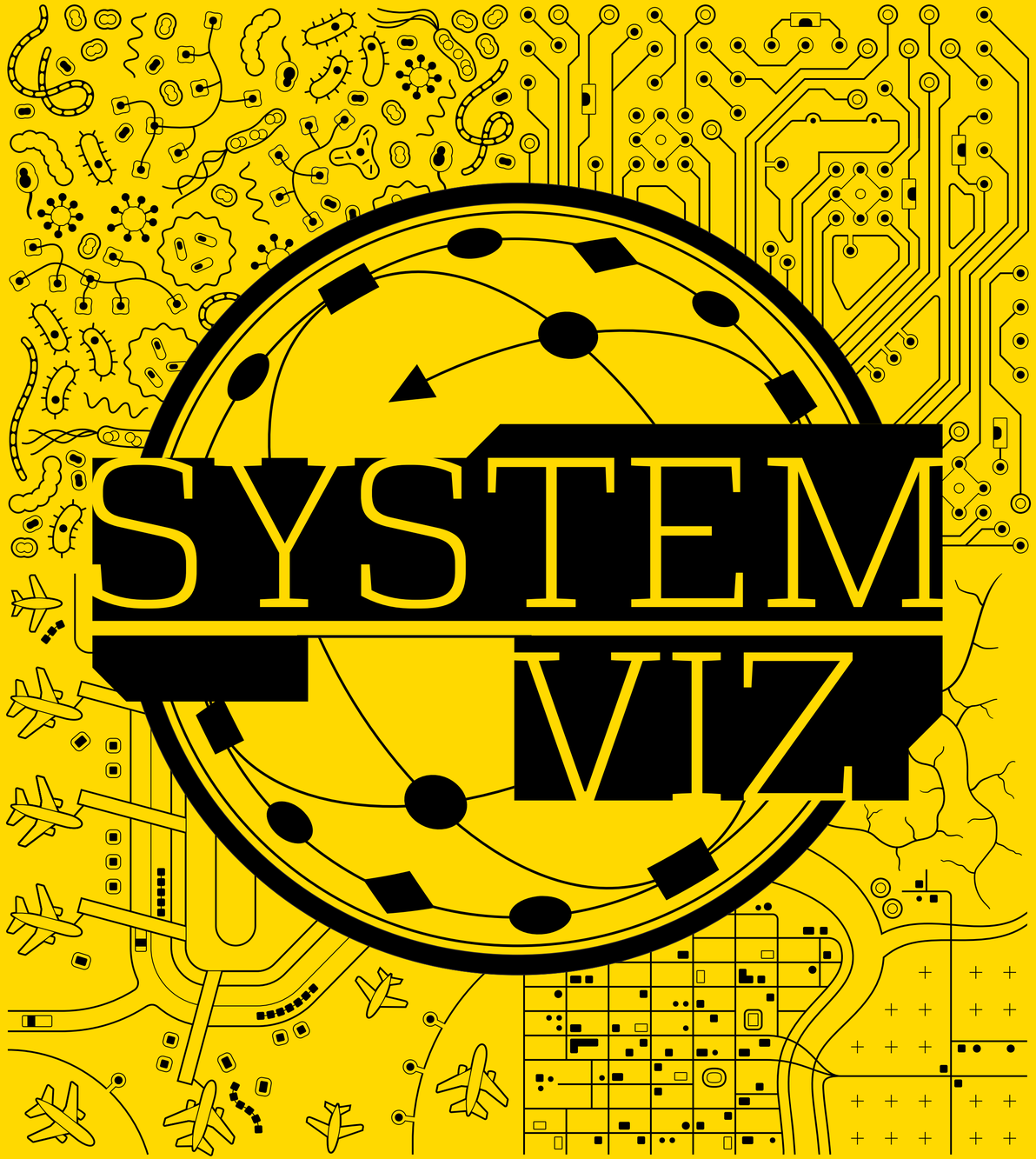
the bee-side

THE FLIP SIDE OF THE PRINTED POSTER WILL SHOW AN EXAMPLE OF THE VISUAL VOCABULARY IN ACTION.

(FORTHCOMING)

AN **APIARY** HARVESTS HONEY FROM BEE COLONIES.
IT IS ALSO AN EXAMPLE OF INTEGRATED SYSTEMS
UNDER THREAT OF LARGE-SCALE COLLAPSE.





MORE INFORMATION AT

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