Thriving Systems Theory: Pursuing a Universal Foundation of System Design Quality

Les Waguespack, Ph.D.
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Bentley University
Waltham Massachusetts

Presented 2012-3-19 to: School of Computer and Information Sciences,
University of South Alabama

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Overview of This Talk

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- Can science explain design quality – great design?

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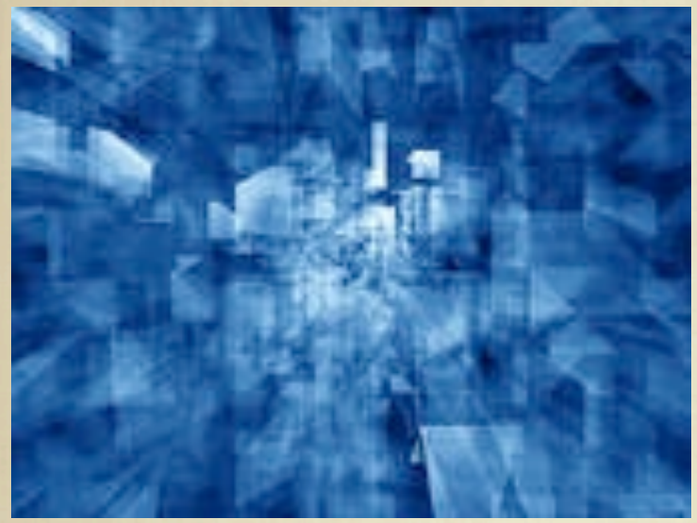
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- Inspiring *Thriving Systems Theory*
  - speculating a fundamental and comprehensive taxonomy of system design quality

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What do we “see” in great design?

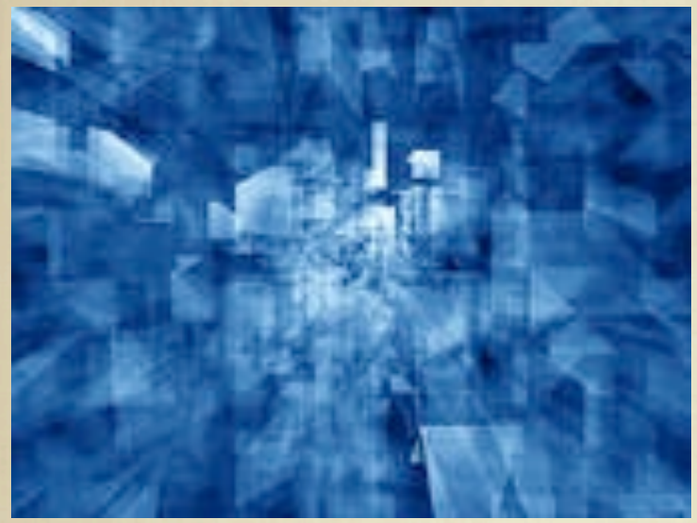
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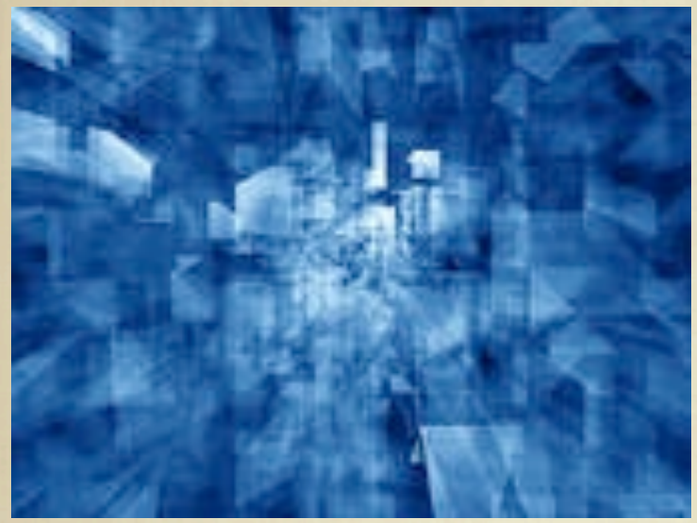
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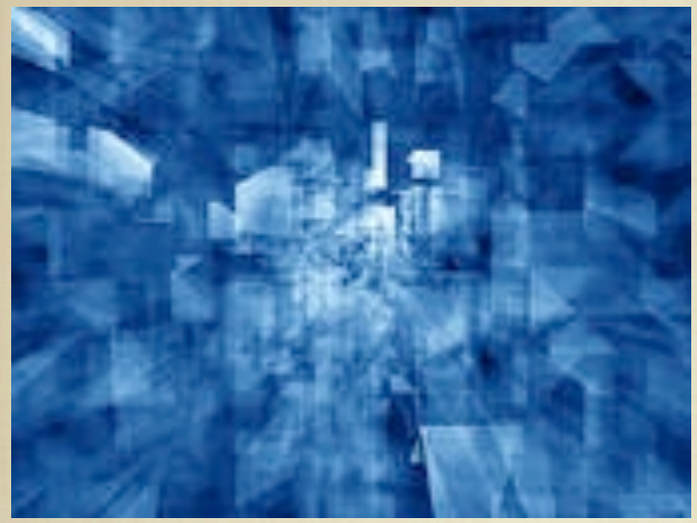






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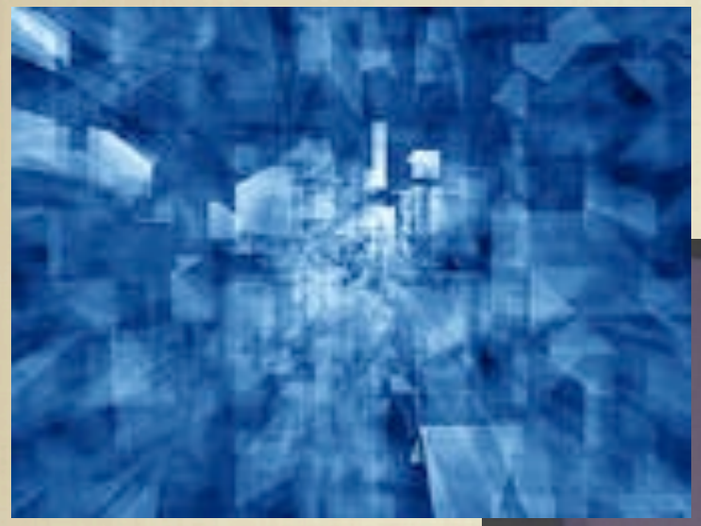






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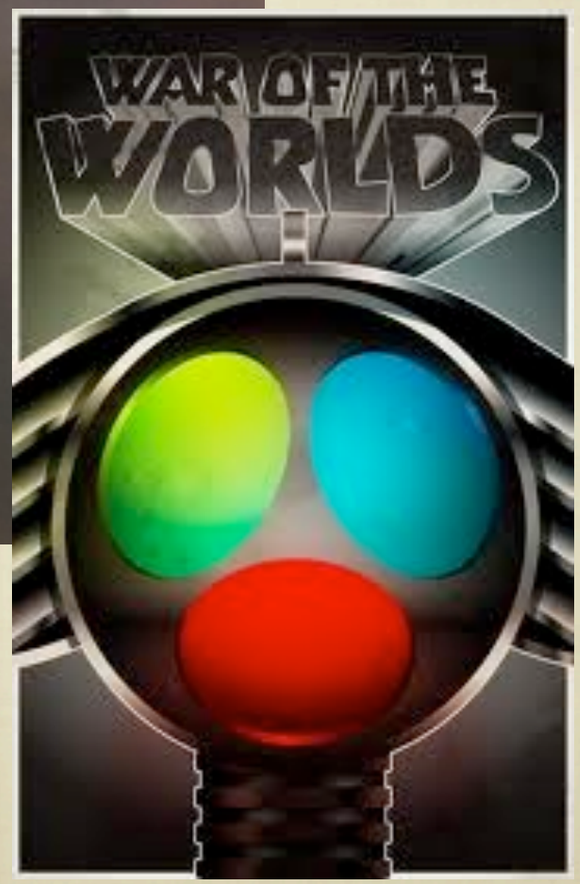
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Waguespack

Thriving Systems Theory and Metaphor-Driven Modeling

How is it that one system is more effective, appealing, satisfying and/or more beautiful than another to its stakeholder community? This question drove Christopher Alexander's fifty-year quest to explain great physical architecture and give birth to pattern-languages for building that underpin much of modern systems engineering.

How is it that so many individual stakeholders consistently recognize the same quality, the same beauty in a system? This question led George Lakoff to research the role of conceptual metaphor in human understanding.

What is essential to stakeholders' satisfaction with systems? Fred Brooks addressed this question in No Silver Bullet: Essence and Accidents of Software Engineering.

This monograph fuses these diverse streams of thought in proposing Thriving Systems Theory by translating Alexander's properties of physical design quality into the abstract domain of information systems and modeling. Metaphor-Driven Modeling incorporates the theory while examining its impact throughout the system life cycle: modeling, design and deployment. The result is holistic and innovative, a perspective on system quality invaluable to students, practitioners and researchers of software and systems engineering.

Les Waguespack is a computer science Ph.D., professor and chairperson of computer information systems at Bentley University, USA. Dr. Waguespack's experience as programmer, software engineer, software architect, database architect, project manager and systems consultant underpins 35 years of teaching and research, the last 20+ years teaching object-oriented modeling and systems engineering to undergraduates, graduate students and practicing professionals.

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Waguespack

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Leslie J. Waguespack

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Springer

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Monograph in Two Parts

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  - a vocabulary of elemental properties describing system elements appropriate to a particular domain
  - a taxonomy of system quality resulting from the interplay of those elemental properties

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  - metaphorology and its role in both the conception and communication of knowledge
  - metaphor as the implement of design in analysis, representation and realization of information systems

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- Fitness for purpose (Sales and supply goods act:UK 1994)
- The degree to which the inherent characteristics fulfill requirements (ISO 9000:2005)

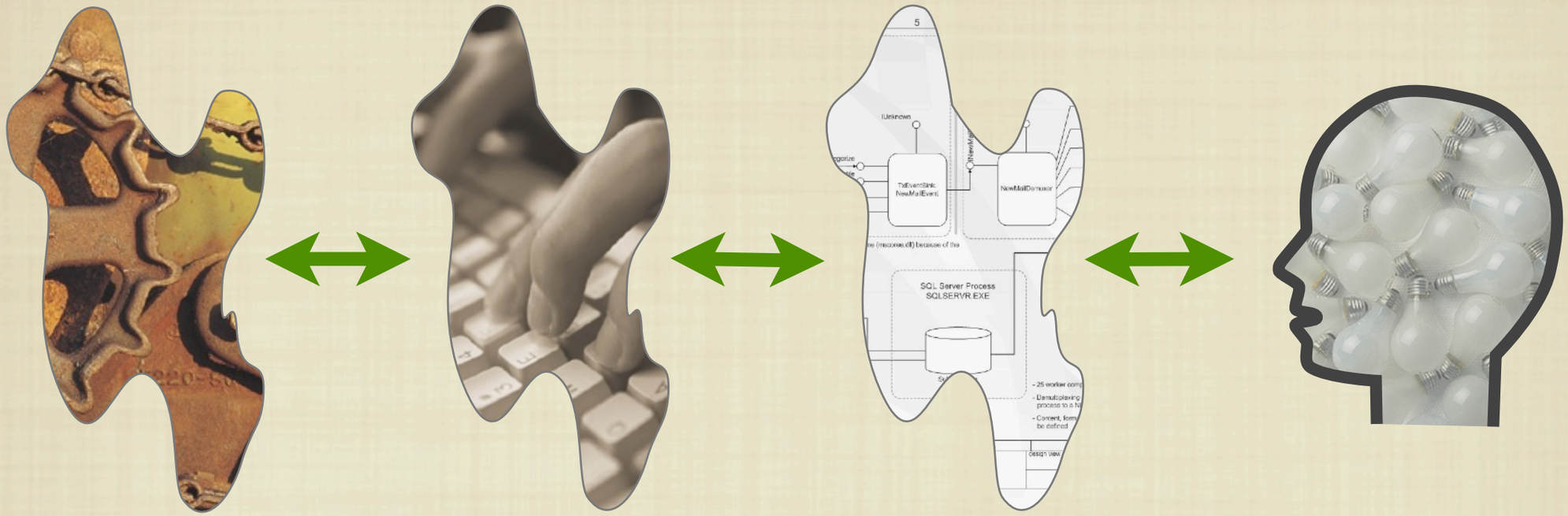
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- Sustained satisfaction (Deming 1993)

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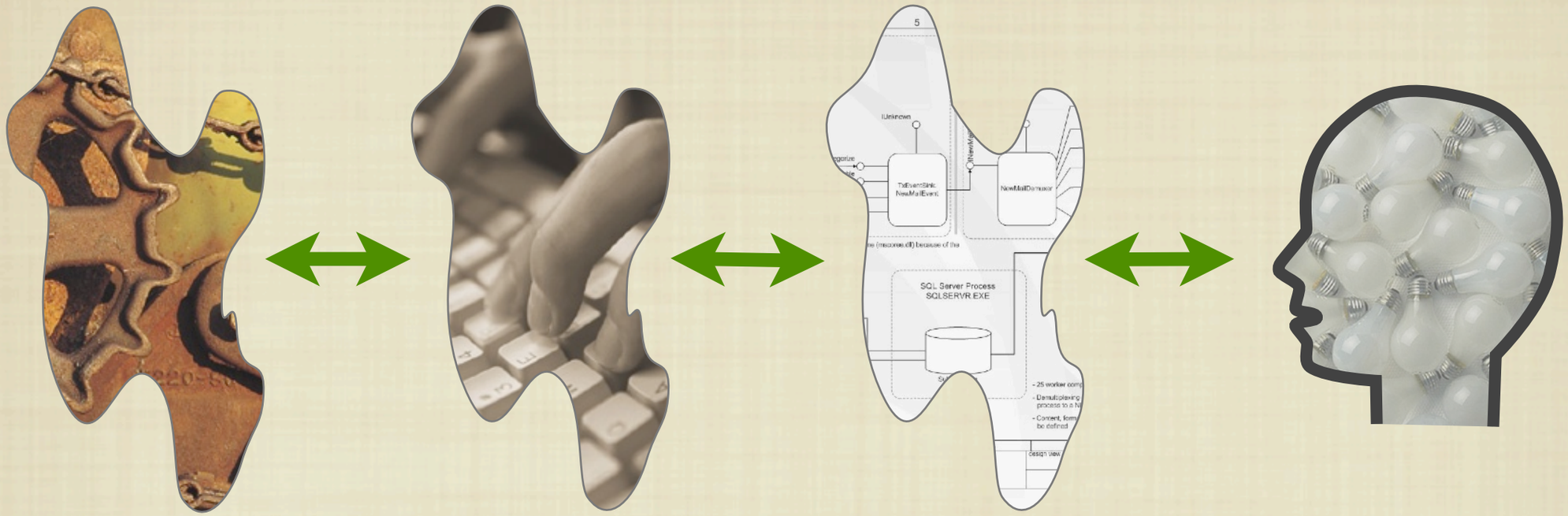
the individual's experience of design quality



implementation threshold expectation mindset

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the individual's experience of design quality

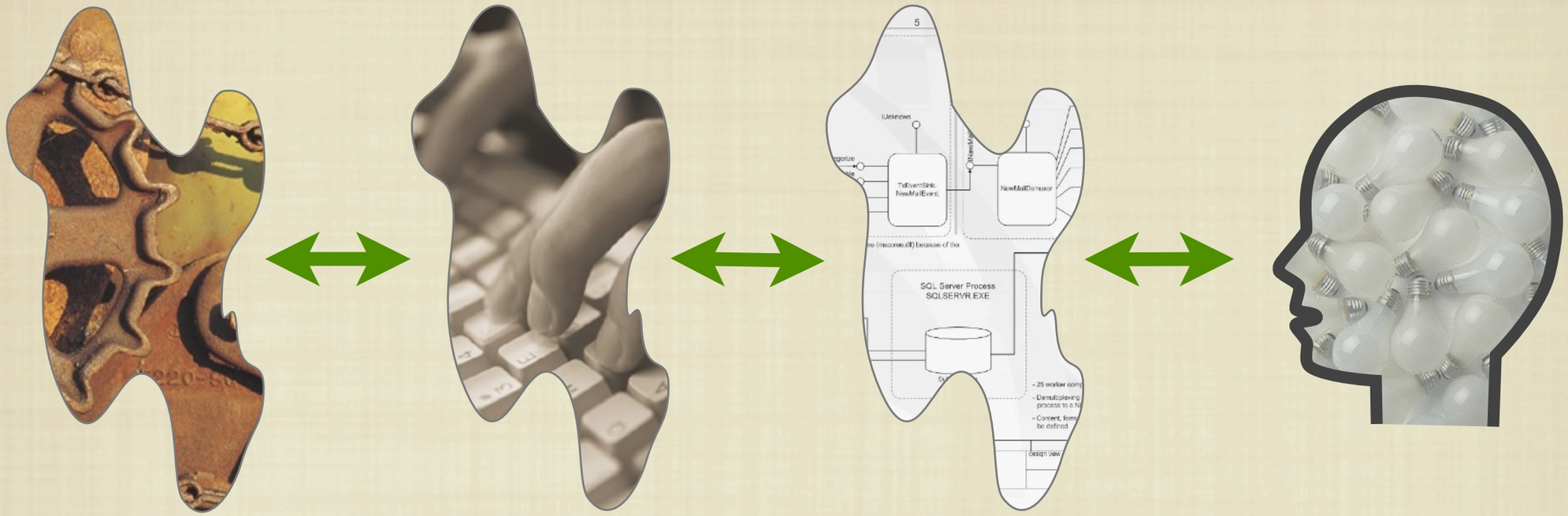


implementation threshold expectation mindset

the "mental picture" the observer brings to the experience within which they will "understand" the experience

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the individual's experience of design quality



implementation

threshold

expectation

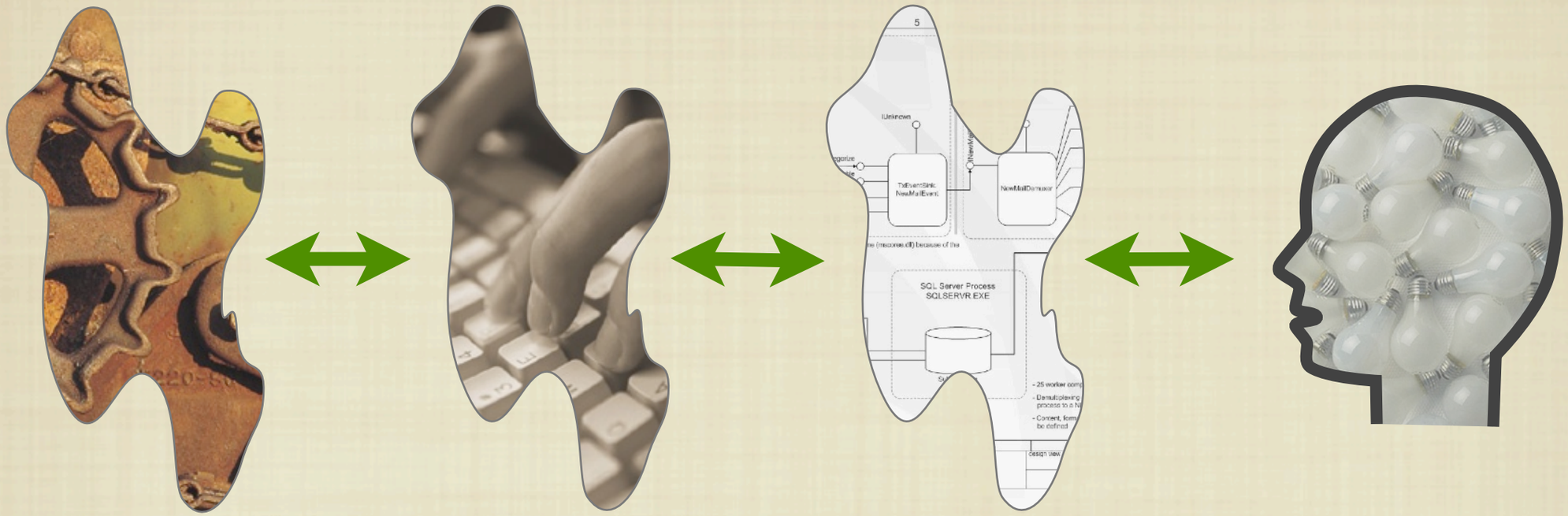
the subset of the observer's mindset (conscious or unconscious) that is specifically relevant to the event

mindset

the "mental picture" the observer brings to the experience within which they will "understand" the experience

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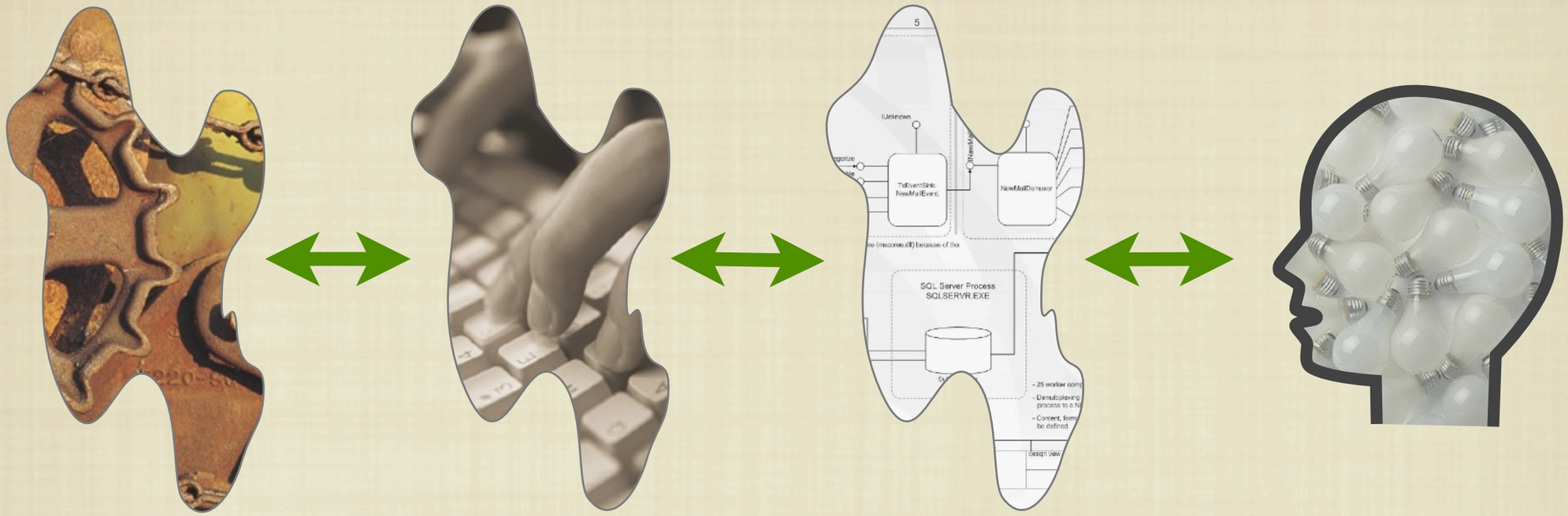
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implementation	threshold	expectation	mindset
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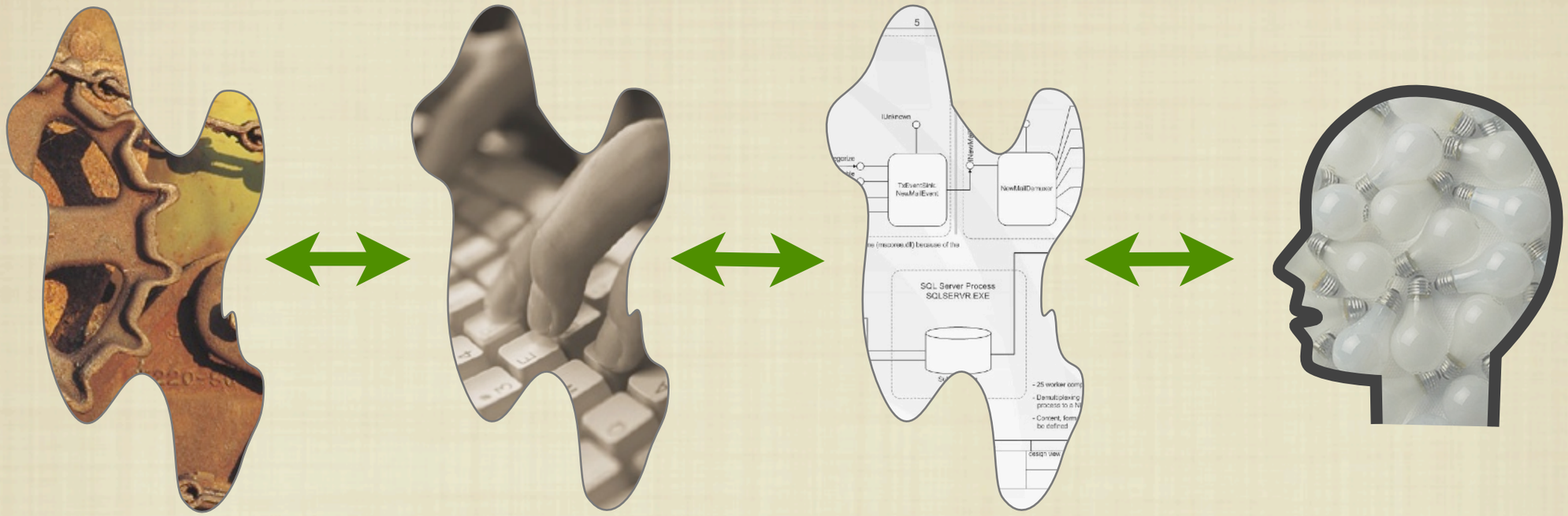
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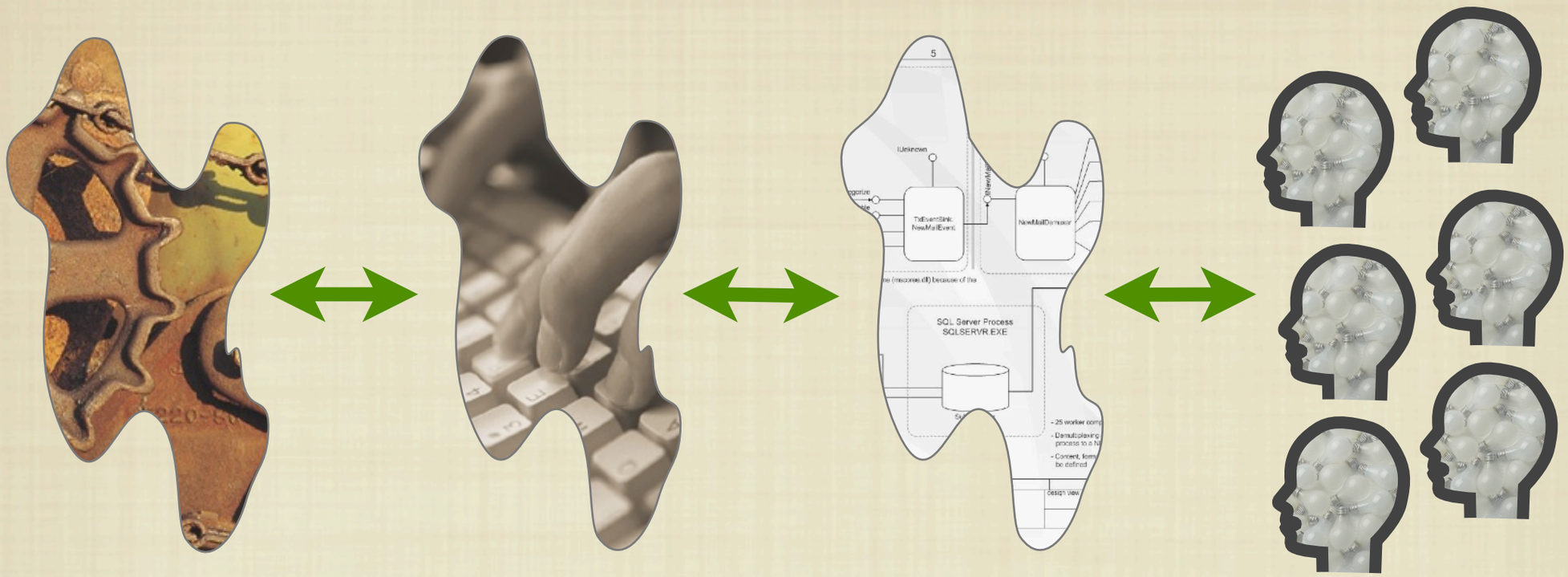
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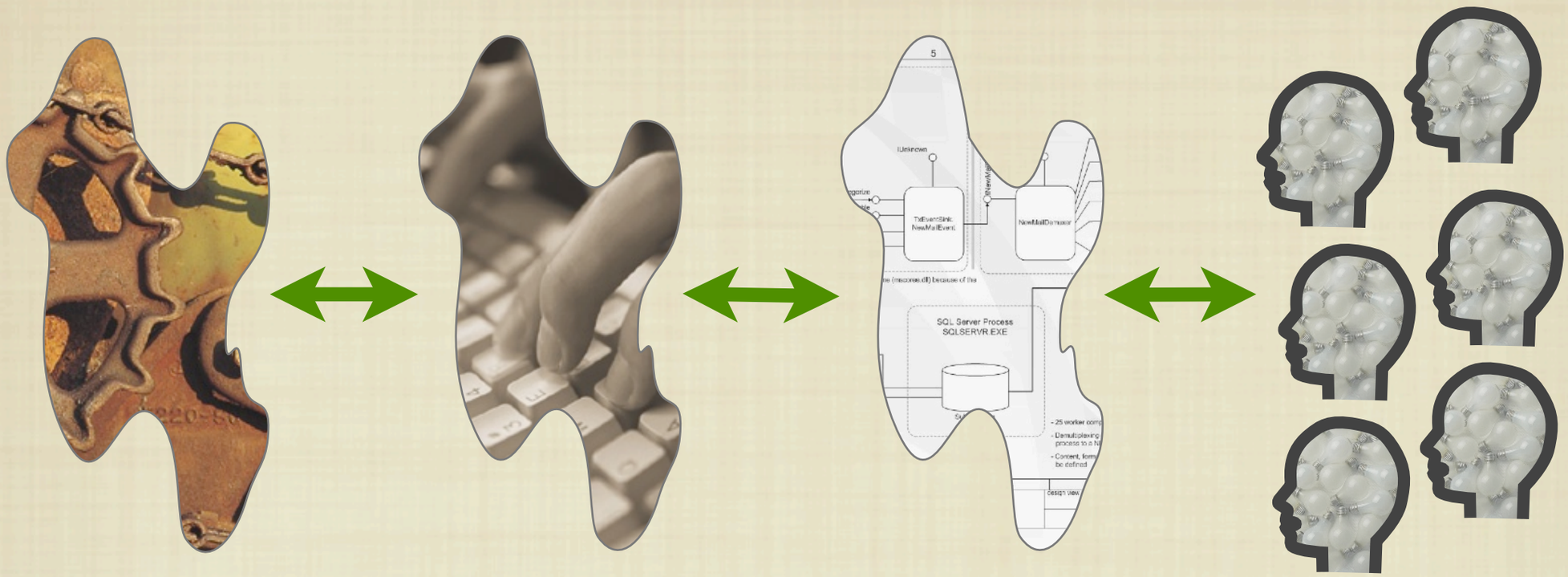
the community's experience of design quality



implementation threshold expectation mindset

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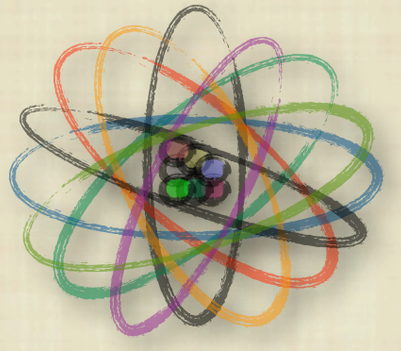
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Thriving Systems Theory

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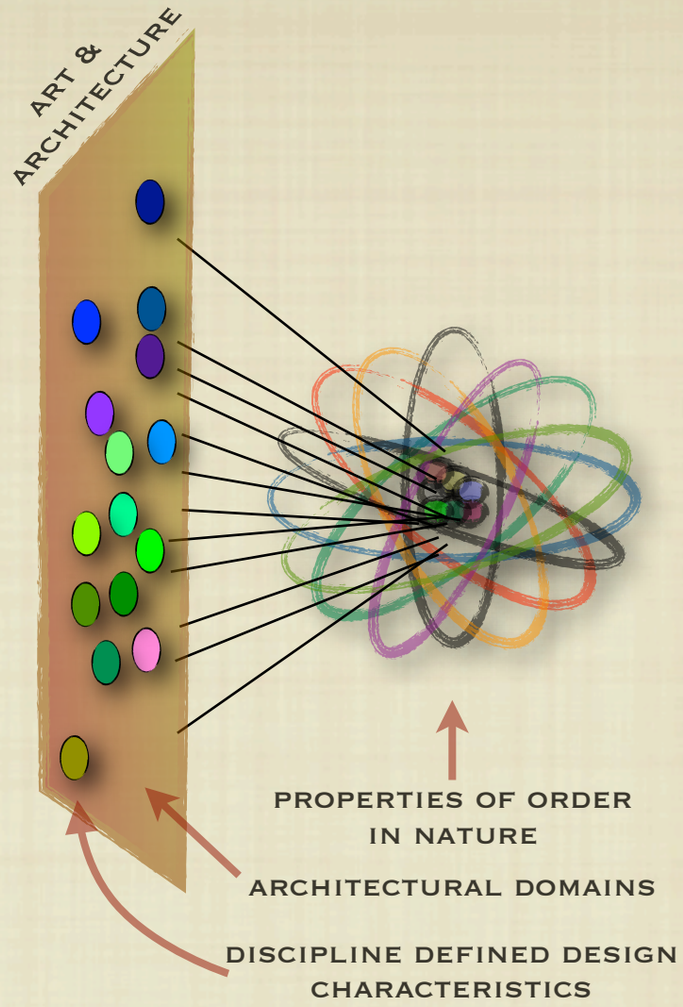
Thriving Systems Theory



PROPERTIES OF ORDER
IN NATURE

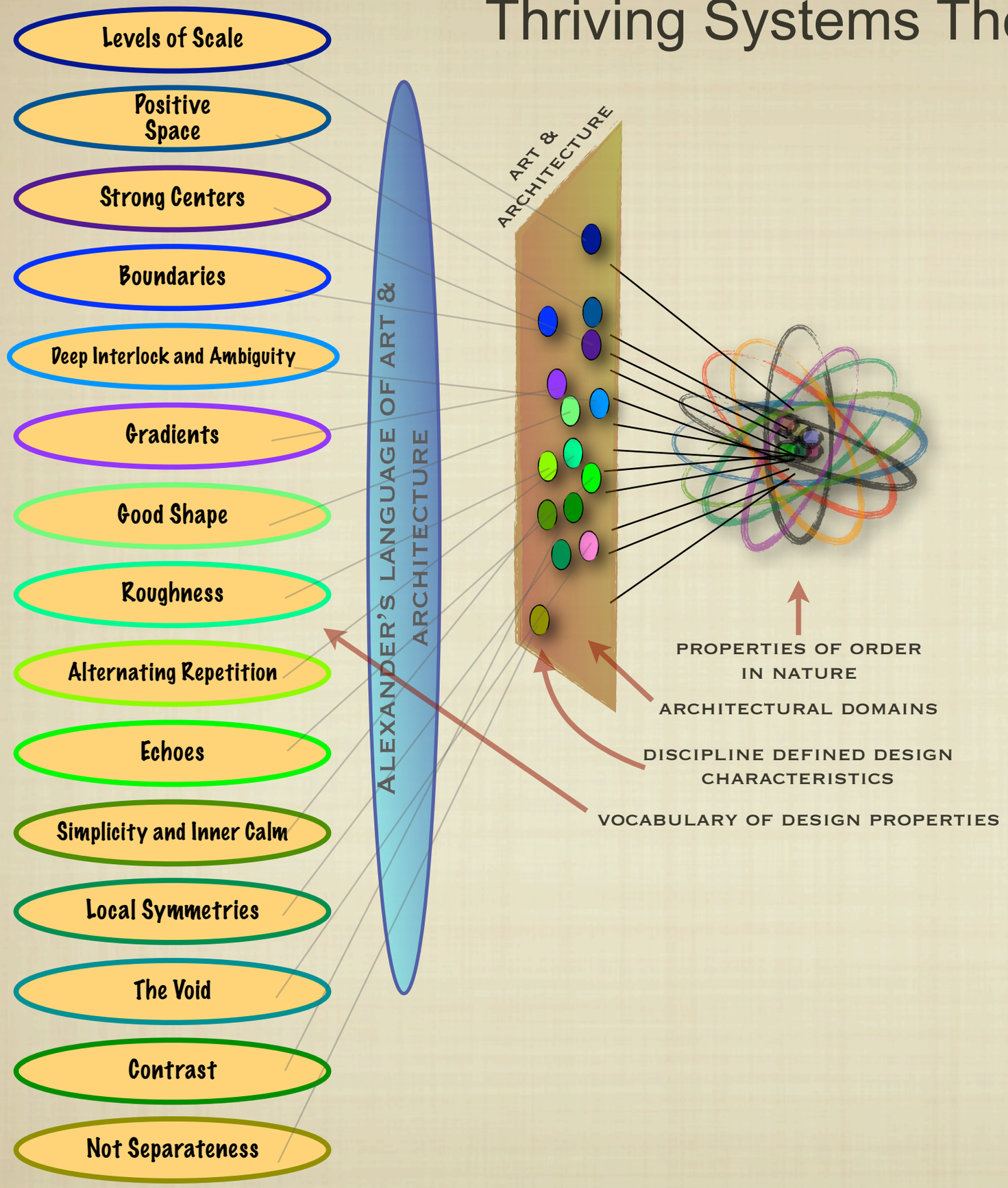
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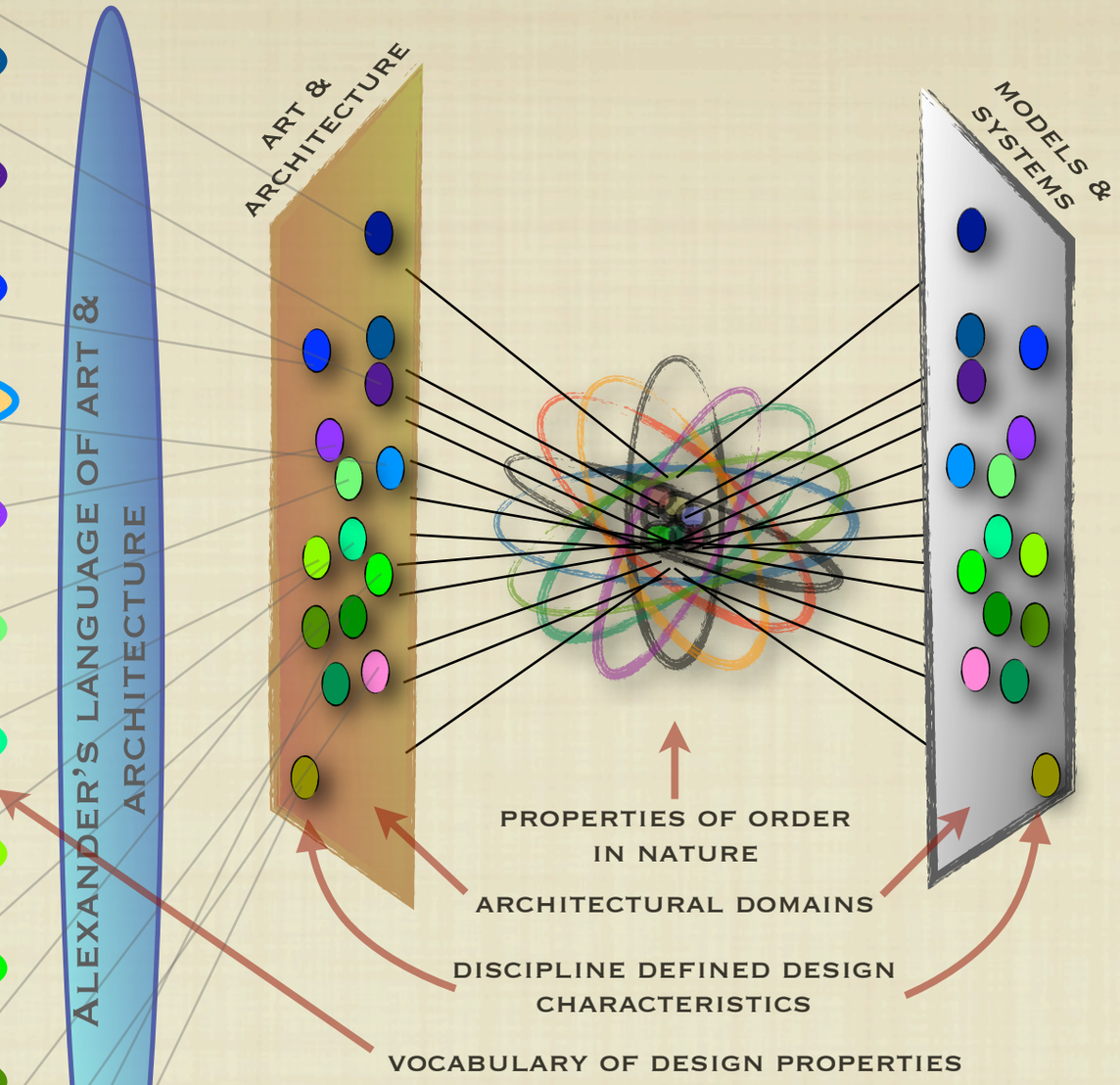
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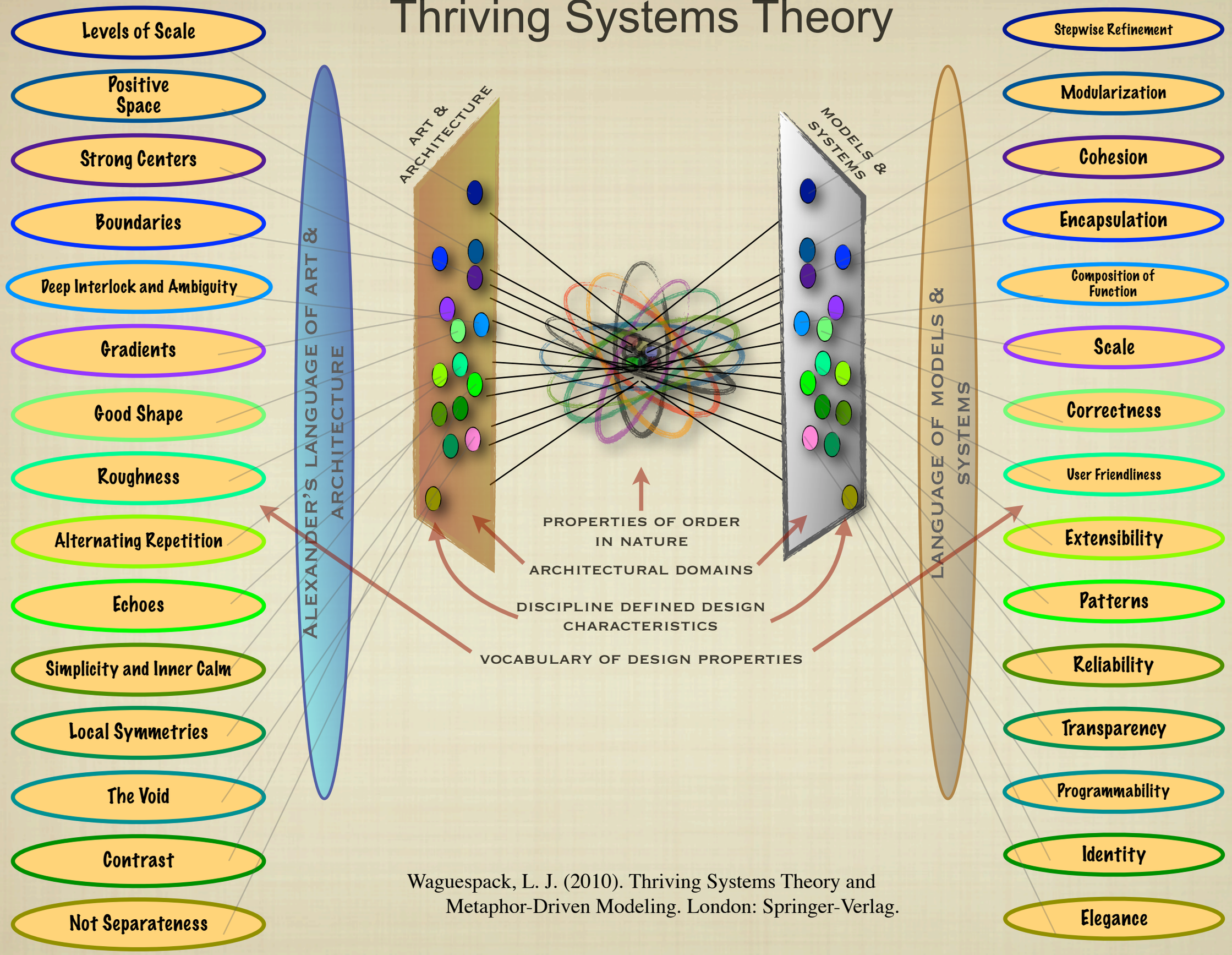
Thriving Systems Theory

- Levels of Scale
- Positive Space
- Strong Centers
- Boundaries
- Deep Interlock and Ambiguity
- Gradients
- Good Shape
- Roughness
- Alternating Repetition
- Echoes
- Simplicity and Inner Calm
- Local Symmetries
- The Void
- Contrast
- Not Separateness



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Thriving Systems Theory



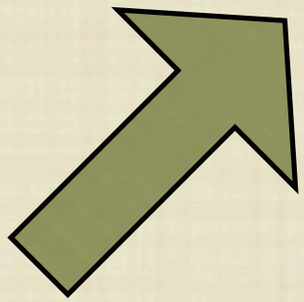
Waguespack, L. J. (2010). Thriving Systems Theory and Metaphor-Driven Modeling. London: Springer-Verlag.

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A Search For Fundamental Principles Of System Design Quality

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Fred Brooks' Essence and Accidents of Information Systems Development

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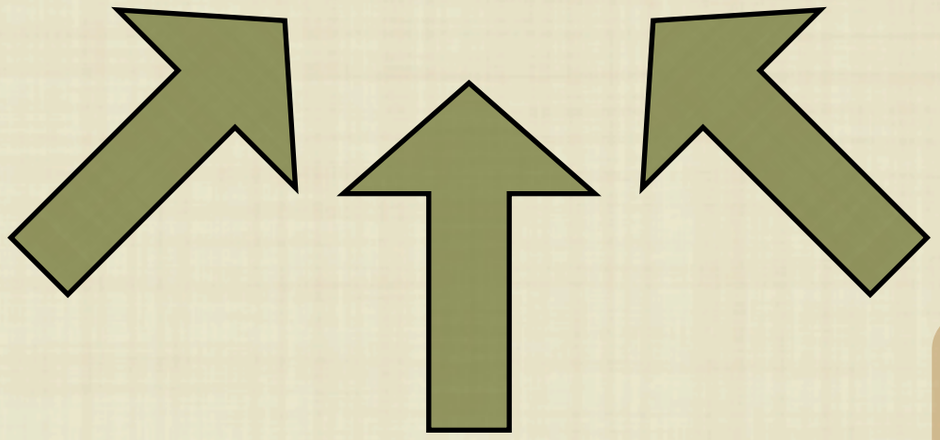


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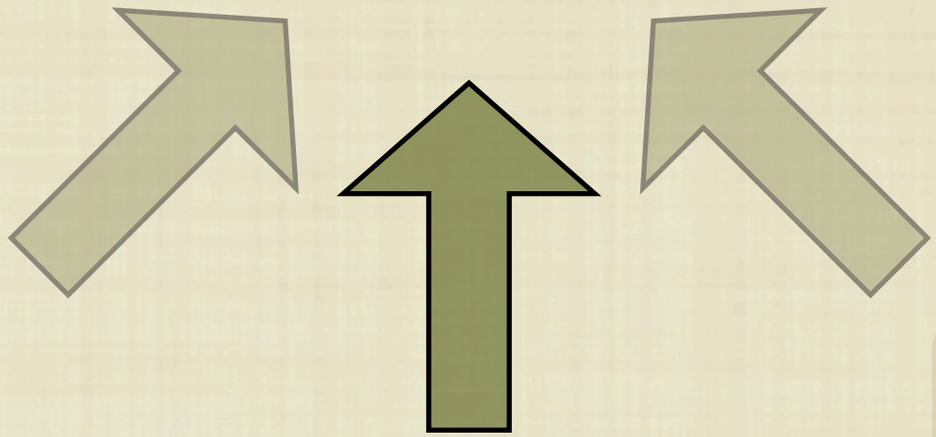
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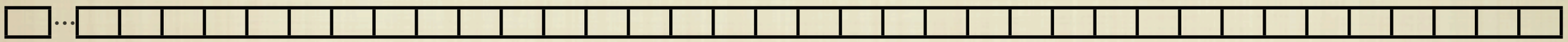
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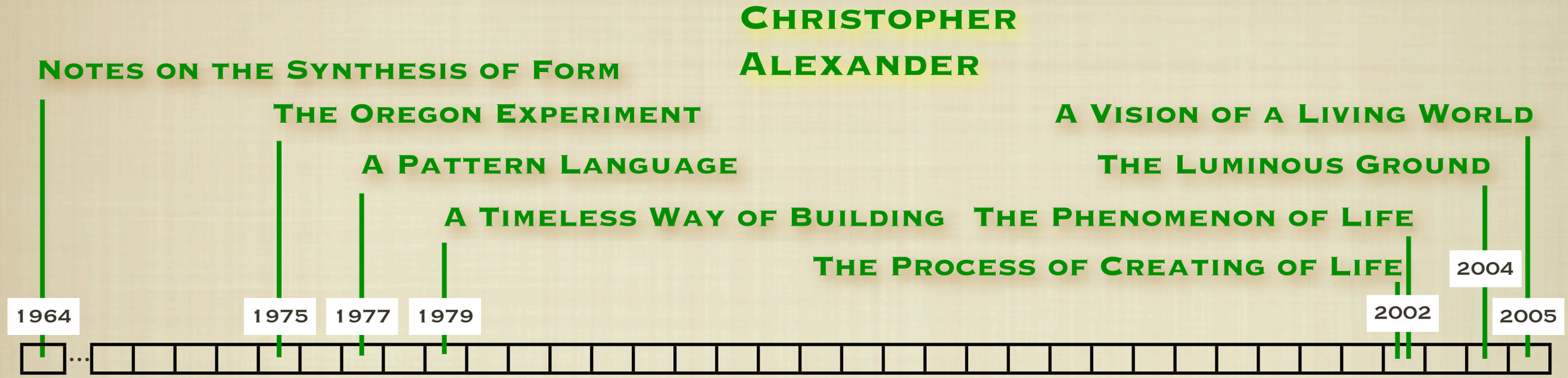
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Threads of Theory in Design



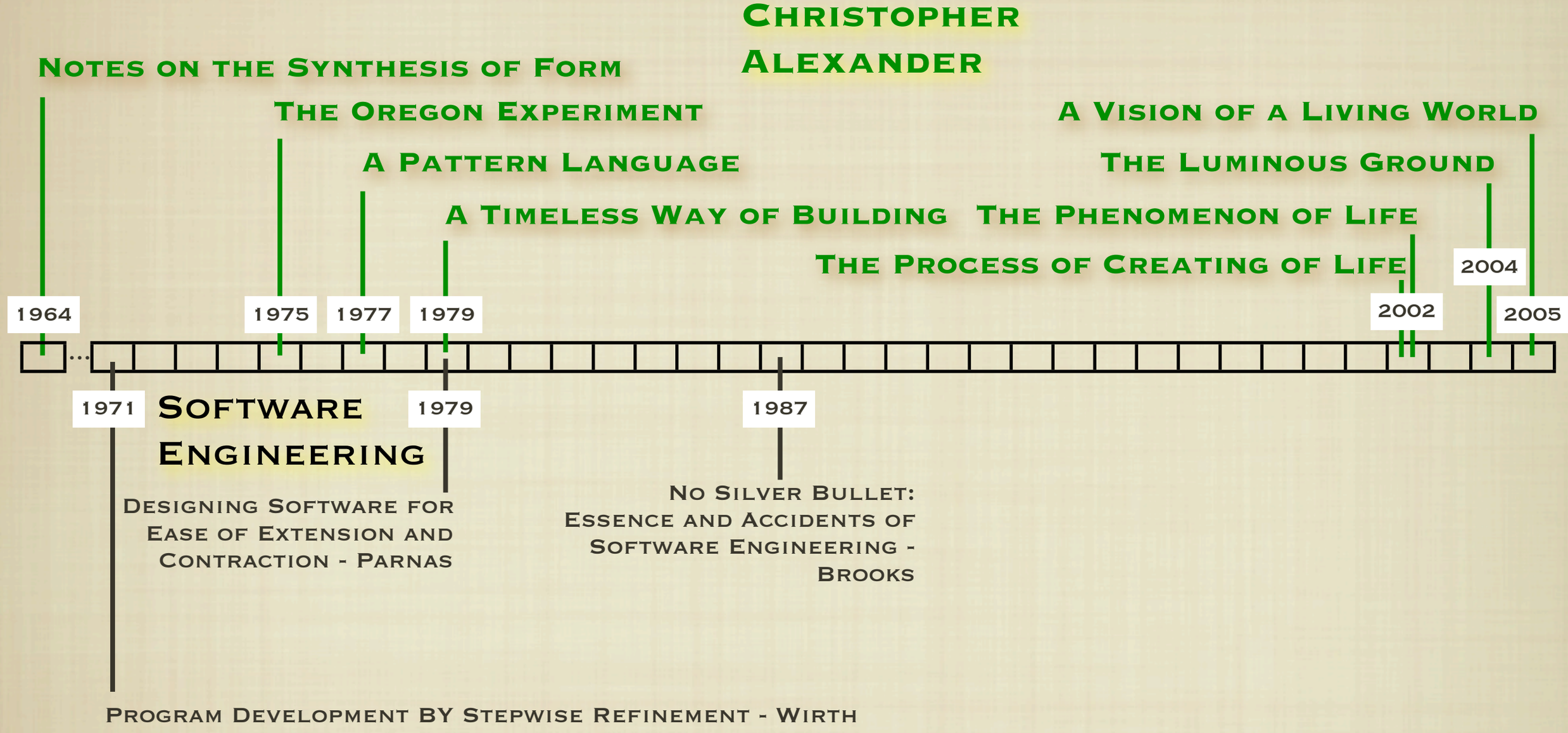
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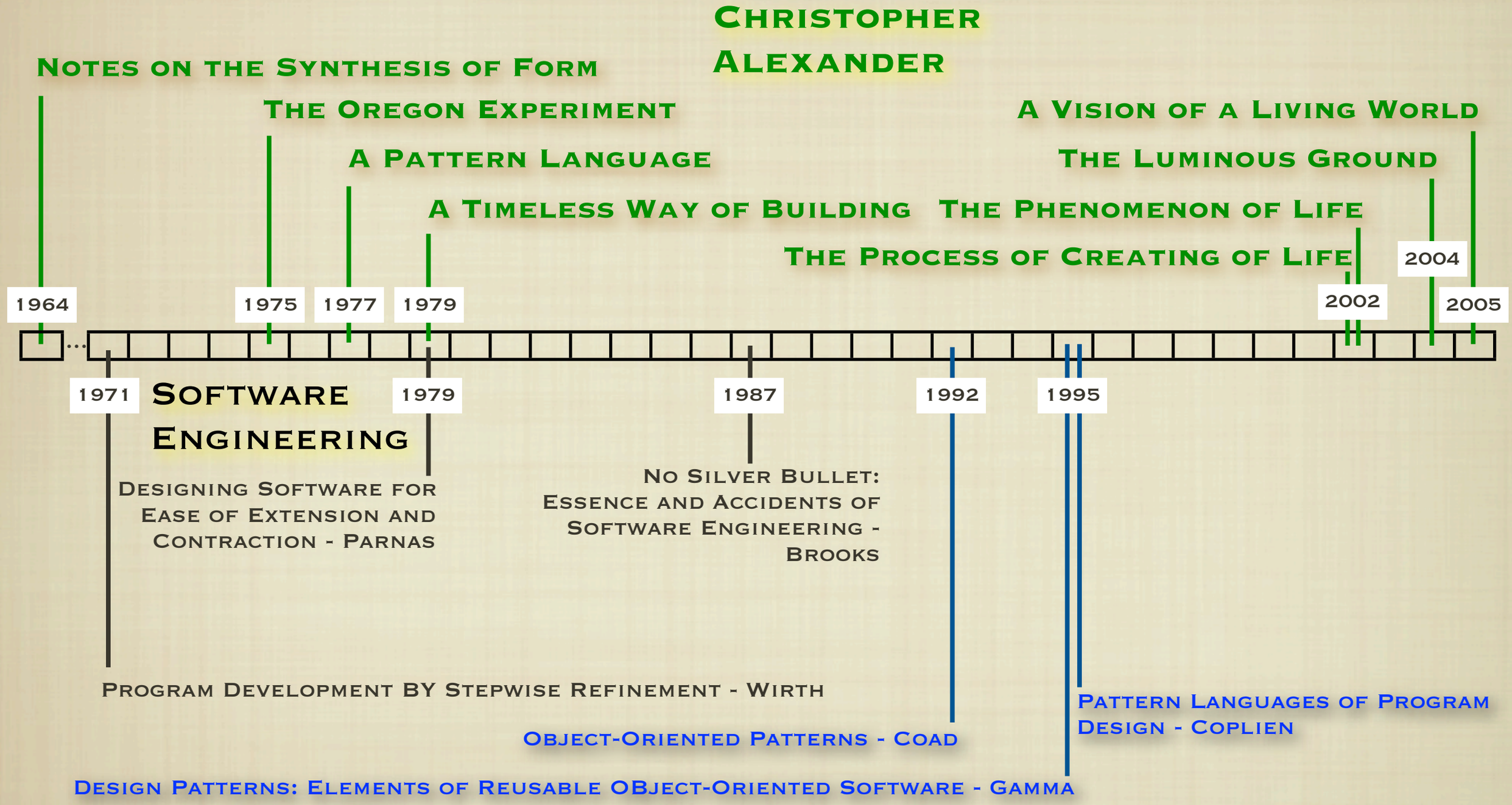
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Threads of Theory in Design

Christopher Alexander

Notes on the Synthesis of Form

The Oregon Experiment

A Pattern Language

A Timeless Way of Building

A Vision of a Living World

The Luminous Ground

The Phenomenon of Life

The Process of Creating of Life

1964 1975 1977 1979 2002 2004 2005

1971 Software Engineering

1979 1980 1987 1992 1995 1999 2000

Designing Software for Ease of Extension and Contraction - Parnas

No Silver Bullet: Essence and Accidents of Software Engineering - Brooks

Where Mathematics Comes From - Lakoff

Philosophy in the Flesh - Lakoff

Metaphors We Live By - Lakoff

Program Development BY Stepwise Refinement - Wirth

Object-Oriented Patterns - Coad

Pattern Languages of Program Design - Coplien

Design Patterns: Elements of Reusable OBject-Oriented Software - Gamma

Object-Oriented Systems Engineering

Cognitive Linguistics

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“I believe the hard part of building software to be the specification, design, and testing of this conceptual construct, not the labor of representing it and testing the fidelity of the representation.”

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George Lakoff's Theories of Metaphor in Cognition

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- The physiology of the human brain is "hard-wired" to store, retrieve, and correlate memory aided by categorization, assimilation, and extension through metaphors recorded, mapped, and processed via neural connections.

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- The physiology of the human brain is "hard-wired" to store, retrieve, and correlate memory aided by categorization, assimilation, and extension through metaphors recorded, mapped, and processed via neural connections.
- Integrated in a spatial-motor sense of our surroundings (reaching for, moving toward or away from, being over, under, inside or outside of, surrounded by) the sensorimotor system of our experience is a continuous source of physical metaphors that frame our consciousness and our subjectivity.

Lakoff, G. and M. Johnson, Metaphors We Live By, University of Chicago Press, Chicago, IL, 1980.
Lakoff, G. and M. Johnson, Philosophy in the Flesh, Basic Books, New York, NY, 1999.
Lakoff, G. and R. Núñez, Where Mathematics Comes From: How the Embodied Mind Brings Mathematics into Being, Basic Books, New York, NY, 2000.

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George Lakoff's Theories of Metaphor in Cognition

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Is design quality "objective," "subjective," or BOTH!?

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Christopher Alexander – *Great Architect*



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OOPSLA 1996 Keynote Speech
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- “Once in a great while, a great idea makes it across the boundary of one discipline to take root in another. The adoption of **Christopher Alexander**’s patterns by the software community is one such event.”



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- “Once in a great while, a great idea makes it across the boundary of one discipline to take root in another. The adoption of **Christopher Alexander**’s patterns by the software community is one such event.”
- “Alexander both commands respect and inspires controversy in his own discipline; he is the author of several books with long-running publication records,
  - the first recipient of the AIA Gold Medal for Research,
  - a member of the Swedish Royal Academy since 1980,
  - a member of the American Academy of Arts and Sciences,
  - recipient of dozens of awards and honors including:
    - the Best Building in Japan award in 1985,
    - the American Association of Collegiate Schools of Architecture Distinguished Award.”



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Christopher Alexander's Theory of **Life** in Architecture

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Humans perceive order "... as elements that systematically conform as constituent components of a whole achieving an arrangement of 'WHOLENESS'."

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Presented any two systems as visual images, in excess of 80% of observers consistently agree upon which exhibits the greater degree of "Life."

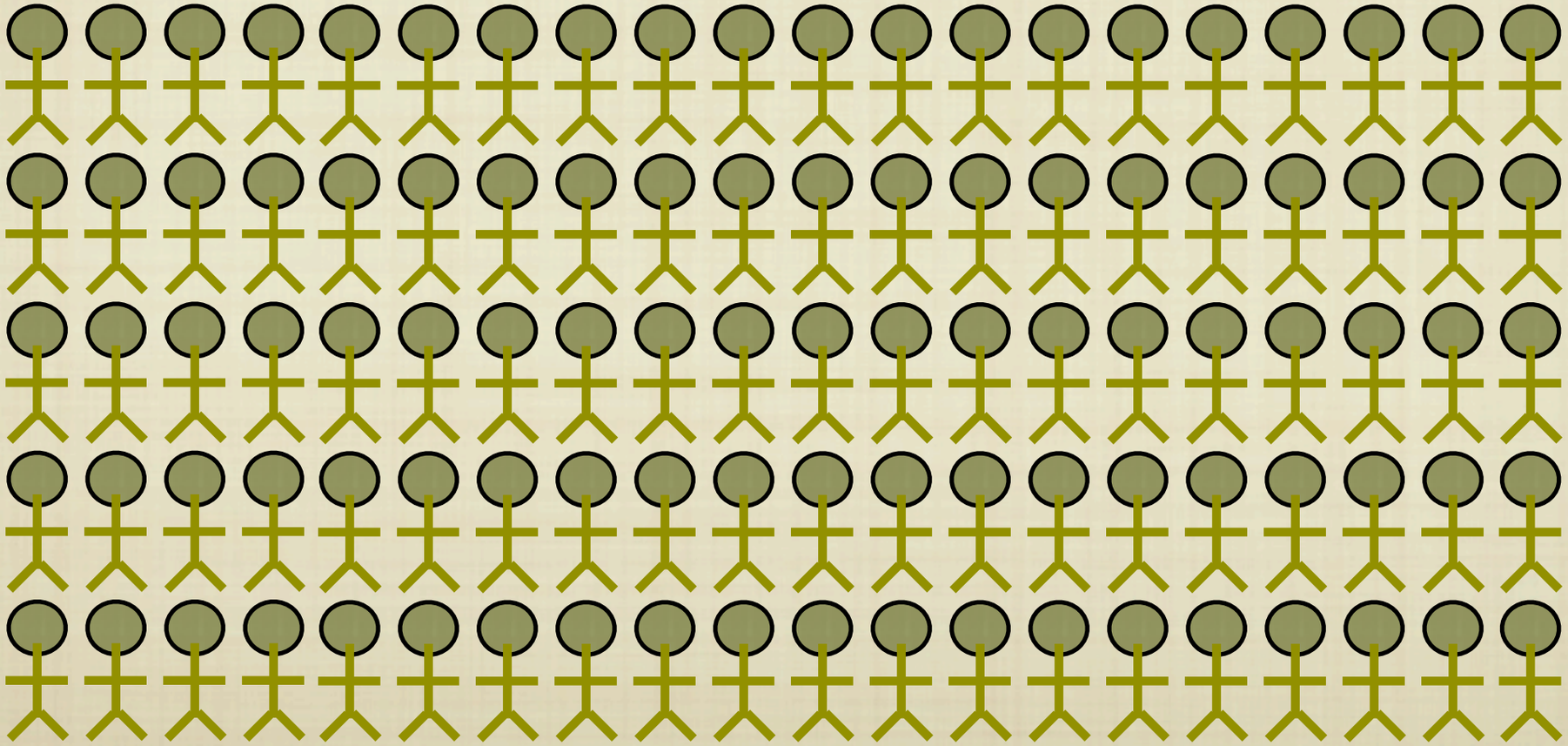
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80+% Consistently Agree

on which system of visual images exhibits more "**Life**"







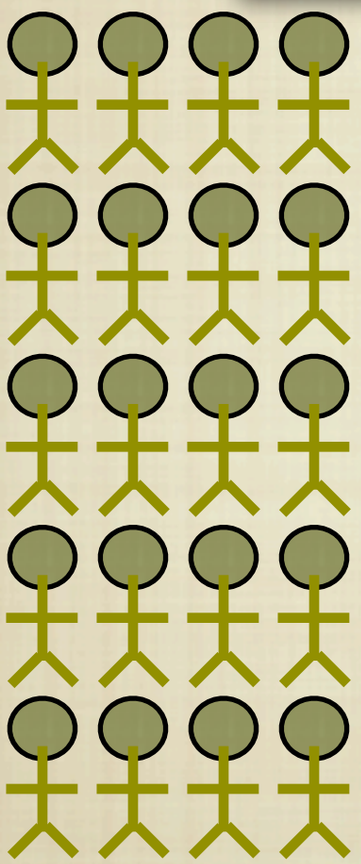
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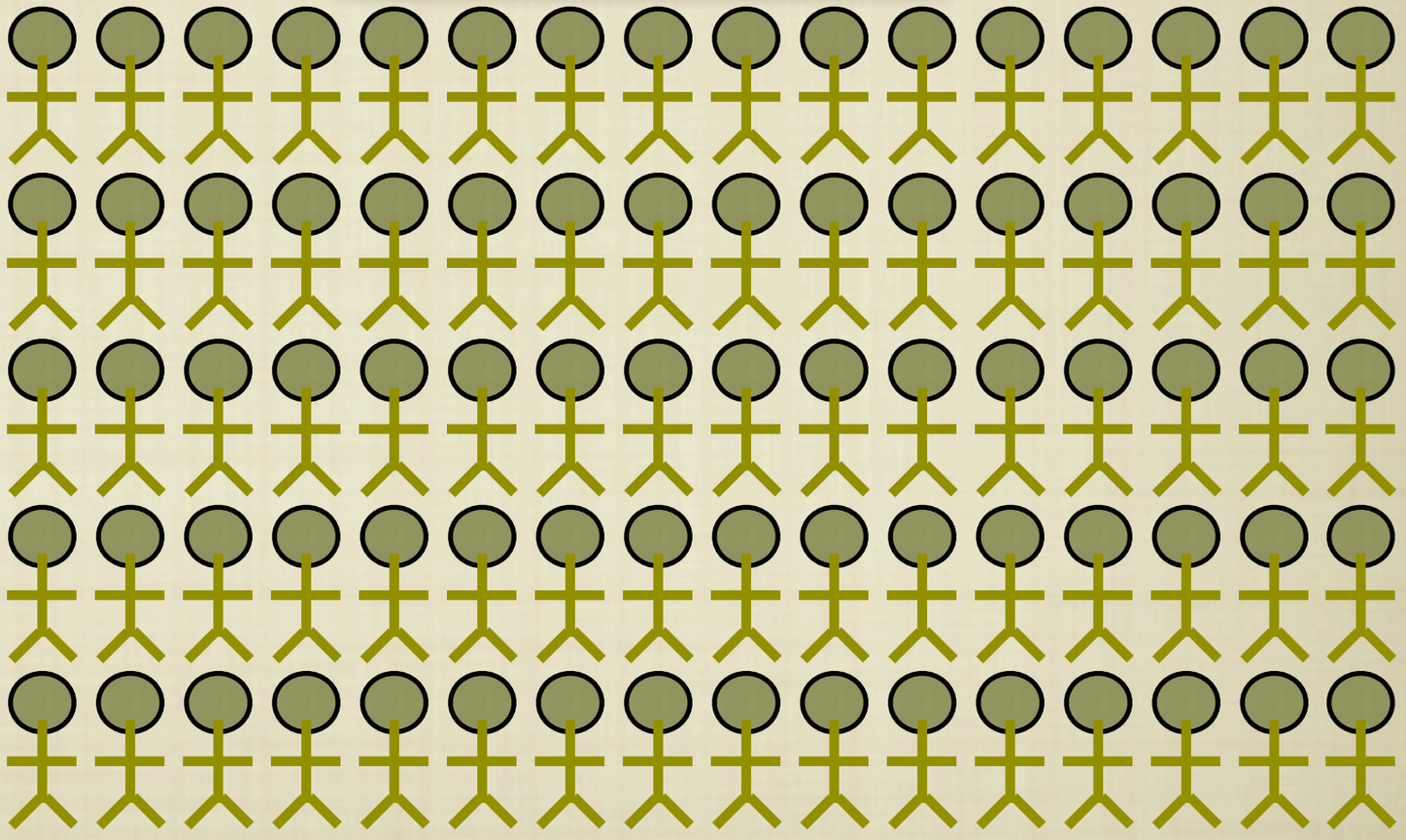
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"The concept extends to any space where objects & relationships are observed."

Alexander, Christopher, The Nature of Order An Essay on the Art of Building and the Nature of the Universe: Book I - The Phenomenon of Life, Berkeley, California: The Center for Environmental Structure, 2002.

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The Nature of Order

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- “The arrangement of things is based upon their arrival at relative positions influenced by forces that guide their movement or evolution. Continuously guided by these forces order emerges and is preserved over time, space, or change as elements systematically conform as constituent components of a whole achieving an arrangement of ‘WHOLENESS’.”

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- Wholeness is stable, disorder is not!

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Centers: the elements of architectural design that form the fabric of Wholeness

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- Center - “a distinct set of points in space, which, because of its organization, because of its internal coherence, and because of its relation to its context, exhibits centeredness, forms a local zone of relative centeredness with respect to other parts of space.” (Alexander)

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- “In any given region of space, some sub-regions have higher intensity as centers; others have less...or none. The overall configurations of their nested centers, together with their relative intensities, comprise a single structure – ‘the’ Wholeness of that region.” (Alexander)

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Center Properties

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- Centers and Wholeness are Everywhere

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Alexander’s 15 Center Properties Expressing Architectural Quality



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Alexander's 15 Center Properties Expressing Architectural Quality

Strong Centers

Not Separateness

Boundaries

Levels of Scale



Positive Space

Gradients

Deep Interlock and Ambiguity

Roughness

Good Shape

Echoes

Alternating Repetition

Local Symmetries

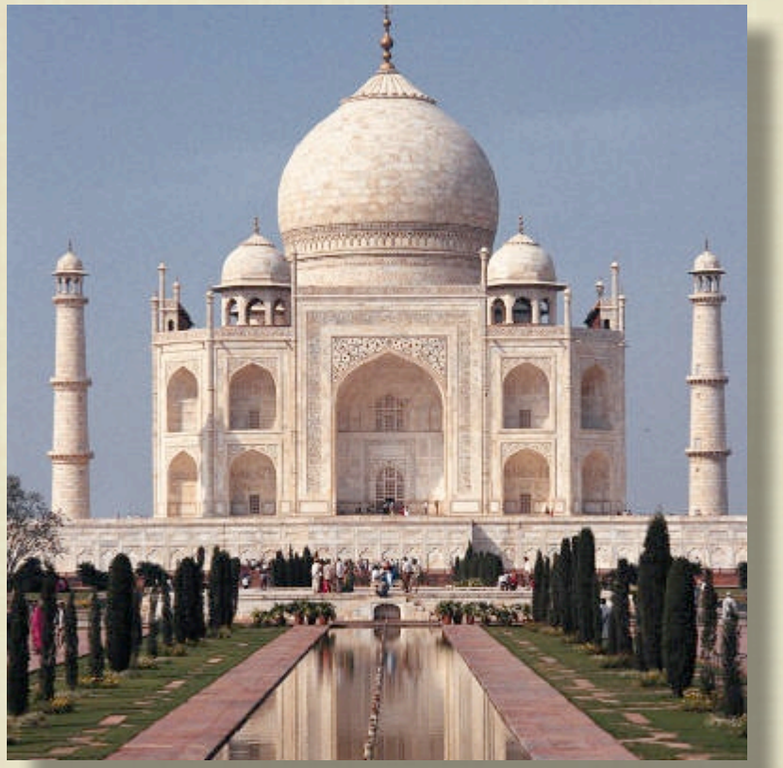
Simplicity and Inner Calm

Contrast

The Void

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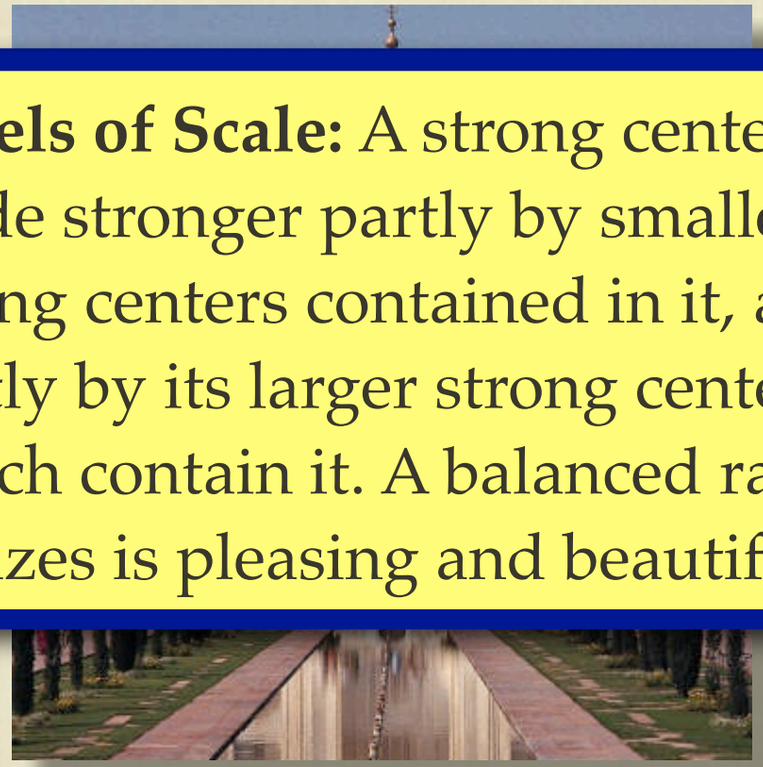
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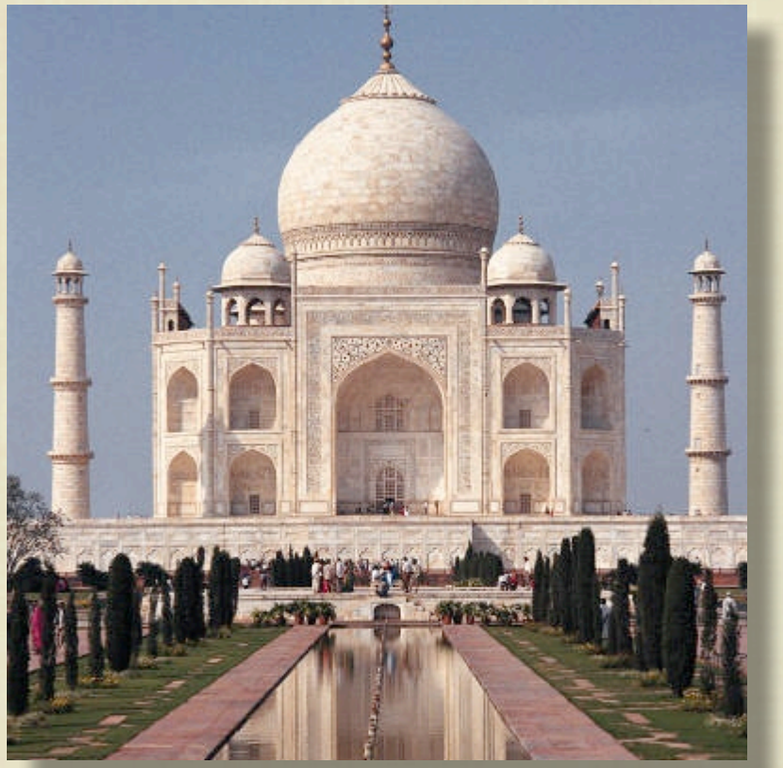
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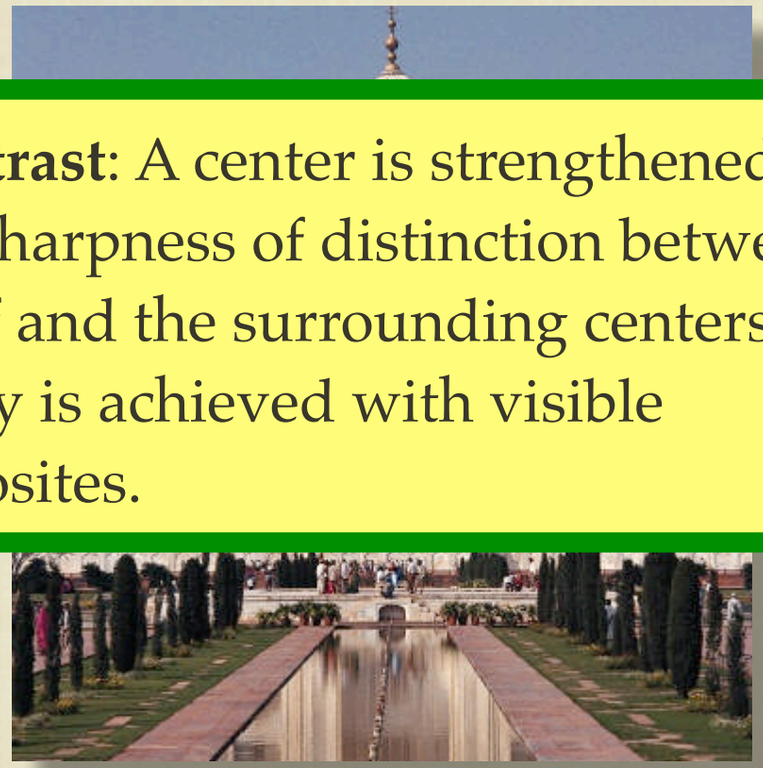
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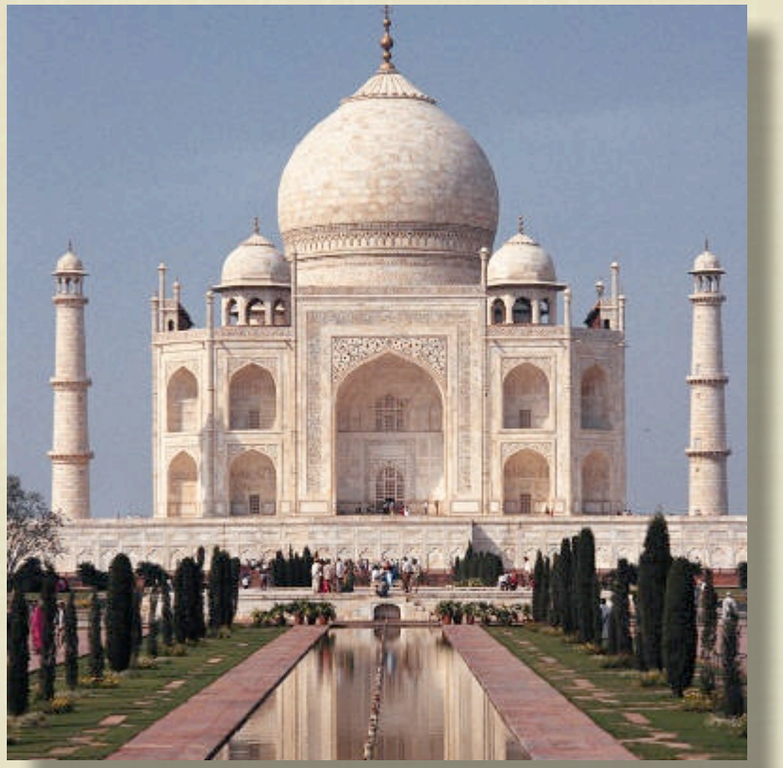
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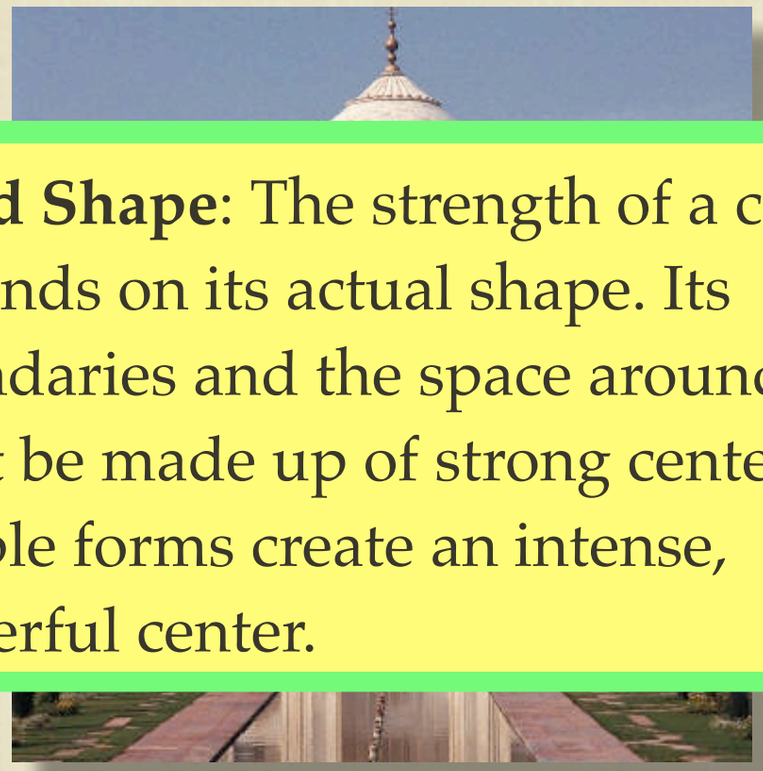
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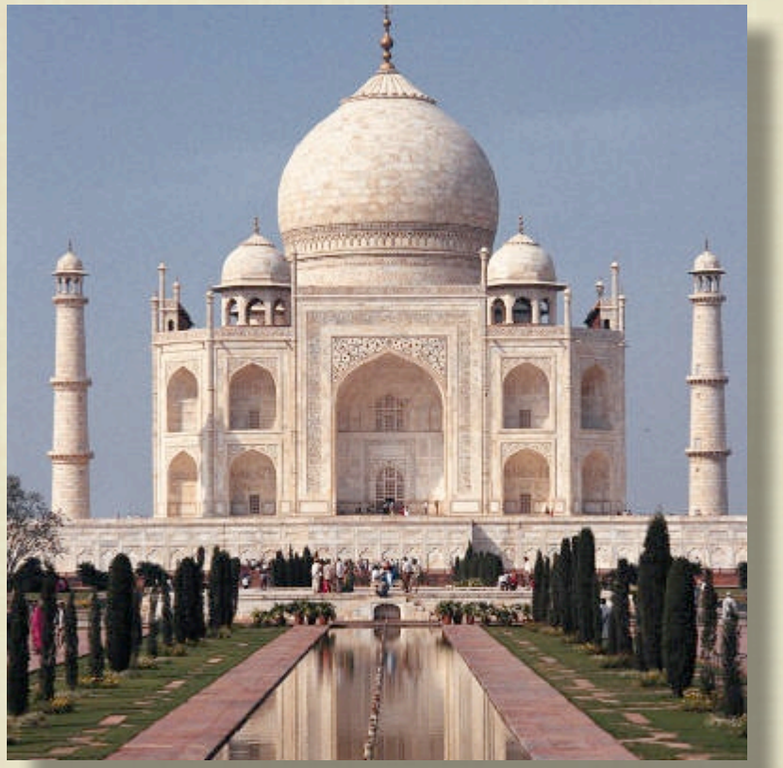
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Local Symmetries
Deep Interlock and Ambiguity
Contrast
Gradients
Roughness
Echoes
The Void
Simplicity and Inner Calm
Not Separateness

a taxonomy / vocabulary of design elements that evoke the experience of quality in architecture,

"The Nature of Order"

discernible in physicality.

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Observable / Attainable

Alexander's 15 Center Properties
Levels of Scale
Strong Centers
Boundaries
Alternating Repetition
Positive Space
Good Shape
Local Symmetries
Deep Interlock and Ambiguity
Contrast
Gradients
Roughness
Echoes
The Void
Simplicity and Inner Calm
Not Separateness

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Observable / Attainable

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Positive Space
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Deep Interlock and Ambiguity
Contrast
Gradients
Roughness
Echoes
The Void
Simplicity and Inner Calm
Not Separateness

observable: *as in assessing the characteristics of an artifact*

attainable: *as in manipulation through design choices*

"Order, Wholeness"

can be pursued in design!

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“The concept extends to any space where objects & relationships are observed.”

Alexander

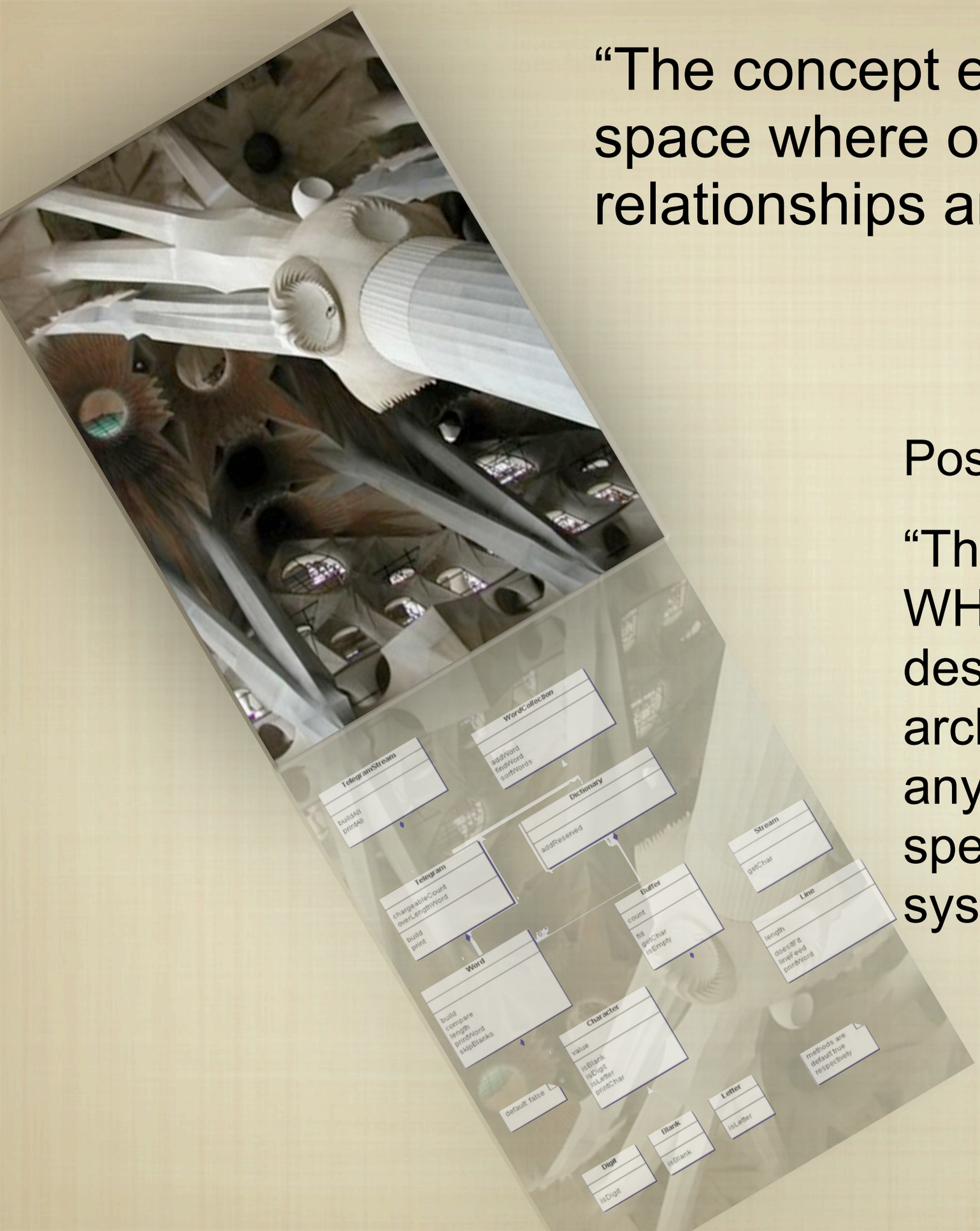
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“The concept extends to any space where objects & relationships are observed.”

Alexander

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"The concept extends to any space where objects & relationships are observed."

Alexander

Postulation:

"The elements of order, the WHOLENESS, that Alexander describes for physical architecture are perceptible in any architectural system – specifically information systems."

Waguespack

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Center transliterates as Choice in a conceptual world of abstractions

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Center transliterates as Choice in a conceptual world of abstractions

- Alexander's concepts are expressed in a vocabulary of physical, visible structure.

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- In this cognitive space we use the term choice as the dual of Alexander's center.
- Center properties of the physical transliterate as structural, relational, and/or congruence characteristics of choices.

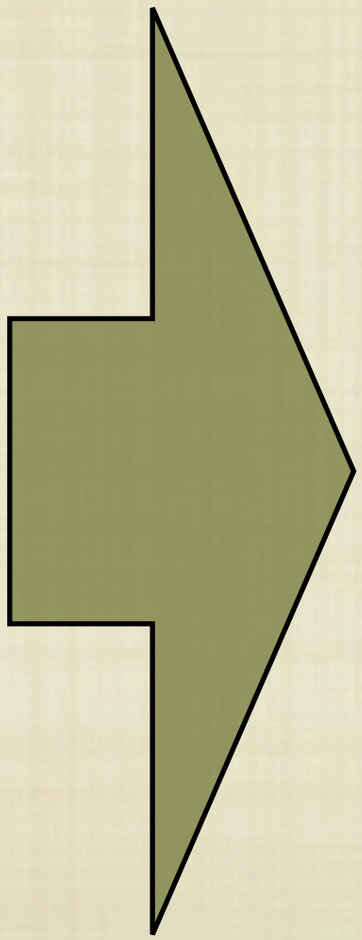
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Translating the Properties from Centers to Choices

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Translating the Properties from Centers to Choices

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Simplicity and Inner Calm
Not Separateness



Vocabulary of Choice Properties
Stepwise Refinement
Cohesion
Encapsulation
Extensibility
Modularization
Correctness
Transparency
Composition of Function
Identity
Scale
User Friendliness
Patterns
Programmability
Reliability
Elegance

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	Choice Property	Modeling Action	Action Rendition
1	Stepwise Refinement	elaborate	develop or present (a theory, policy, or system) in detail
2	Cohesion	factor	express as a product of factors
3	Encapsulation	encapsulate	enclose the essential features of something succinctly by a protective coating or membrane
4	Extensibility	extend	render something capable of expansion in scope, effect, or meaning
5	Modularization	modularize	employing or involving a module or modules as the basis of design or construction
6	Correctness	align	put (things) into correct or appropriate relative positions
7	Transparency	expose	reveal the presence of (a quality or feeling)
8	Composition of Function	assemble	fit together the separate component parts of (a machine or other object)
9	Identity	identify	establish or indicate who or what (someone or something) is
10	Scale	focus	(of a person or their eyes) adapt to the prevailing level of light [abstraction] and become able to see clearly
11	User Friendliness	accommodate	fit in with the wishes or needs of
12	Patterns	pattern	give a regular or intelligible form to
13	Programmability	generalize	make or become more widely or generally applicable
14	Reliability	normalize	make something more normal, which typically means conforming to some regularity or rule
15	Elegance	coordinate	bring the different elements of (a complex activity or organization) into a relationship that will ensure efficiency or harmony

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	Choice Property
1	Stepwise Refinement
2	Cohesion
3	Encapsulation
4	Extensibility
5	Modularization
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8	Composition of Function
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11	User Friendliness
12	Patterns
13	Programmability
14	Reliability
15	Elegance

These choice properties propose a coherent, descriptive language including:

- a vocabulary for describing and comparing aspects of system components and structures, and
- design actions to guide design choices leading to desirable system characteristics.

Advancing the credibility of choice properties

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Advancing the credibility of choice properties

- Is there evidence that the choice properties can be identified in systems that are generally accepted as exhibiting great design?

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Advancing the credibility of choice properties

- Is there evidence that the choice properties can be identified in systems that are generally accepted as exhibiting great design?
- Are there modeling actions in design that can intentionally affect the intensities of the various properties of a choice?

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Advancing the credibility of choice properties

- Is there evidence that the choice properties can be identified in systems that are generally accepted as exhibiting great design?
- Are there modeling actions in design that can intentionally affect the intensities of the various properties of a choice?
- Are such modeling actions transferable across paradigms of artifacts? - Across paradigms of modeling?

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Evidence of Choice Properties in Systems and Modeling

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Evidence of Choice Properties in Systems and Modeling

- Choice Properties in Extant Systems

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Evidence of Choice Properties in Systems and Modeling

- Choice Properties in Extant Systems
  - ☑ APACHE web server (Design Principles & Practices)

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	Choice Property	Modeling Action	Action Definition	Apache Exemplars of Choice Property Strength
1	Stepwise Refinement	**elaborate**	develop or present (a theory, policy, or system) in detail	**Filter chains (2.0)**
2	Cohesion	**factor**	express as a product of factors	**Resources pools**
3	Encapsulation	**encapsulate**	enclose the essential features of something succinctly by a protective coating or membrane	**Platform independence (2.0)**
4	Extensibility	**extend**	render something capable of expansion in scope, effect, or meaning	**Apache server API's (public)**
5	Modularization	**modularize**	employing or involving a module or modules as the basis of design or construction	**Apache server API's (private)**
6	Correctness	**align**	put (things) into correct or appropriate relative positions	**HTTP implementation**
7	Transparency	**expose**	reveal the presence of (a quality or feeling)	**Apache portable runtime (2.0)**
8	Composition of Function	**assemble**	fit together the separate component parts of (a machine or other object)	**Filter chains (2.0)**
9	Identity	**identify**	establish or indicate who or what (someone or something) is	**Management interfaces (2.0)**
10	Scale	**focus**	(of a person or their eyes) adapt to the prevailing level of light [abstraction] and become able to see clearly	**Core elements of server**
11	User Friendliness	**accommodate**	fit in with the wishes or needs of	**Flexible configuration & management (2.0)**
12	Patterns	**pattern**	give a regular or intelligible form to	**Module design patterns**
13	Programmability	**generalize**	make or become more widely or generally applicable	**Hierarchical & layered configuration**
14	Reliability	**normalize**	make something more normal, which typically means conforming to some regularity or rule	**Process lifecycle & resource management**
15	Elegance	**coordinate**	bring the different elements of (a complex activity or organization) into a relationship that will ensure efficiency or harmony	**Configuration change management**

Apache HTTP Web Server

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  - ☐ network architecture

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- Choice Properties Mapped to Modeling

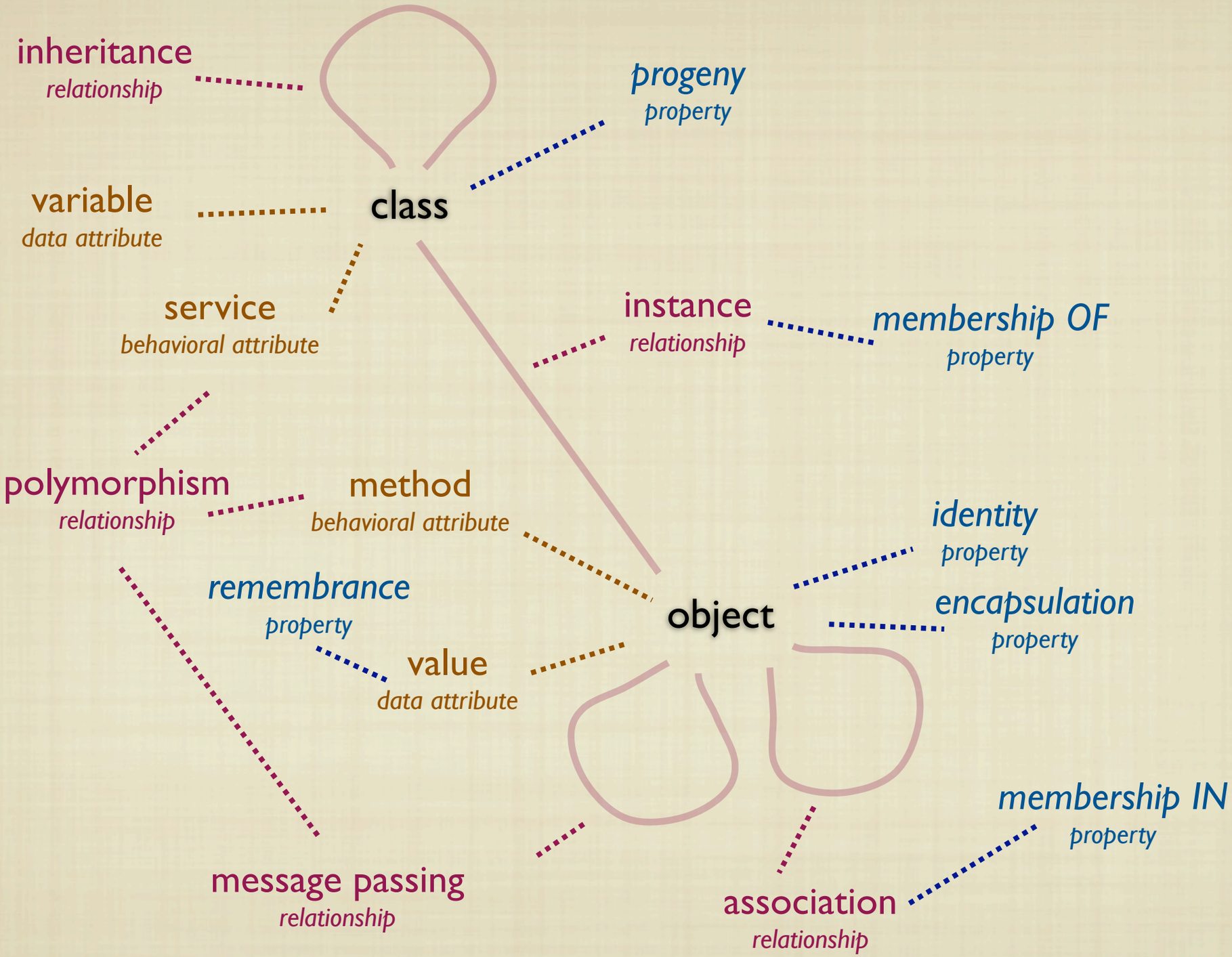
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Object-Oriented Ontology



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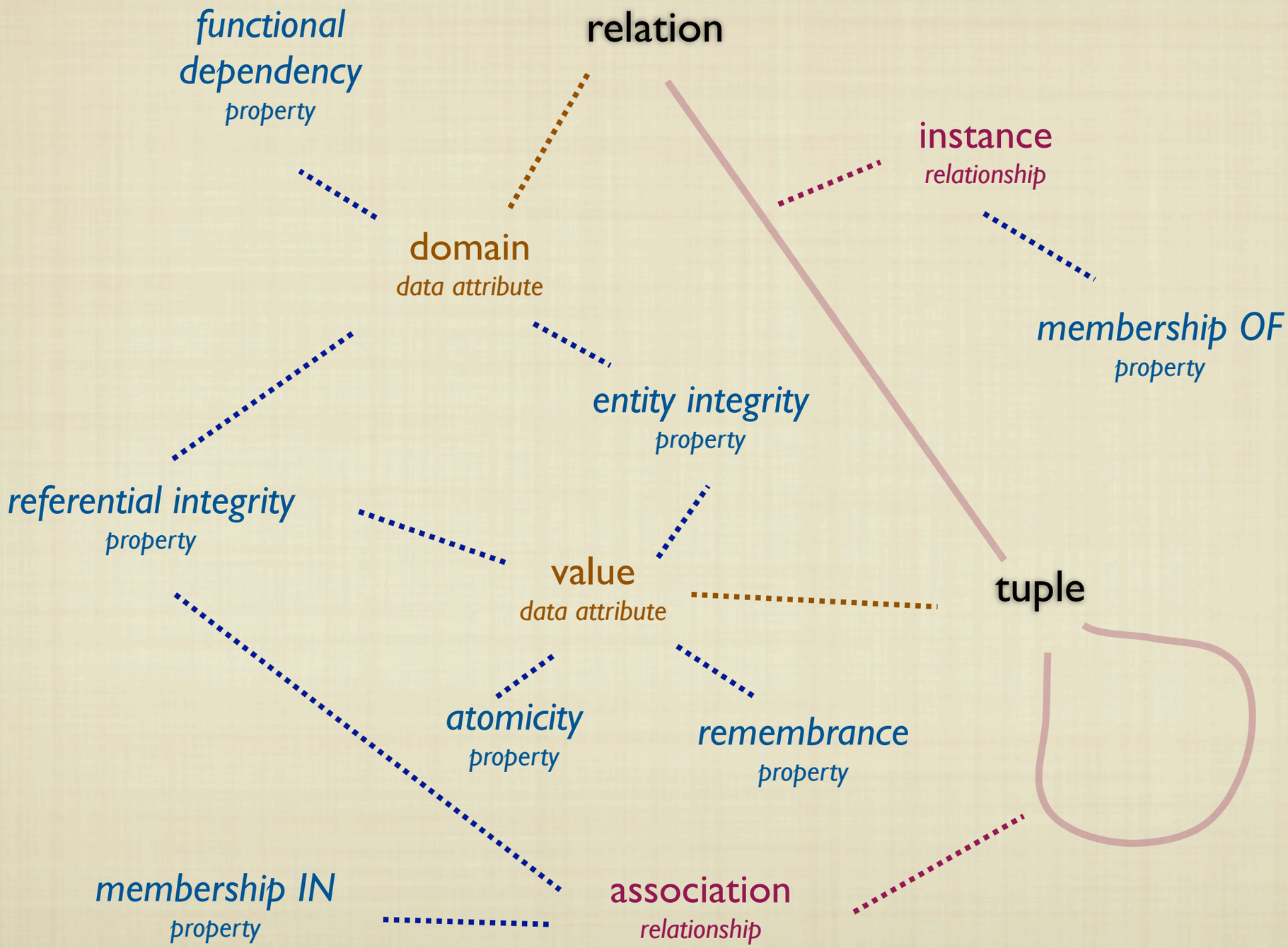
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Relational Ontology



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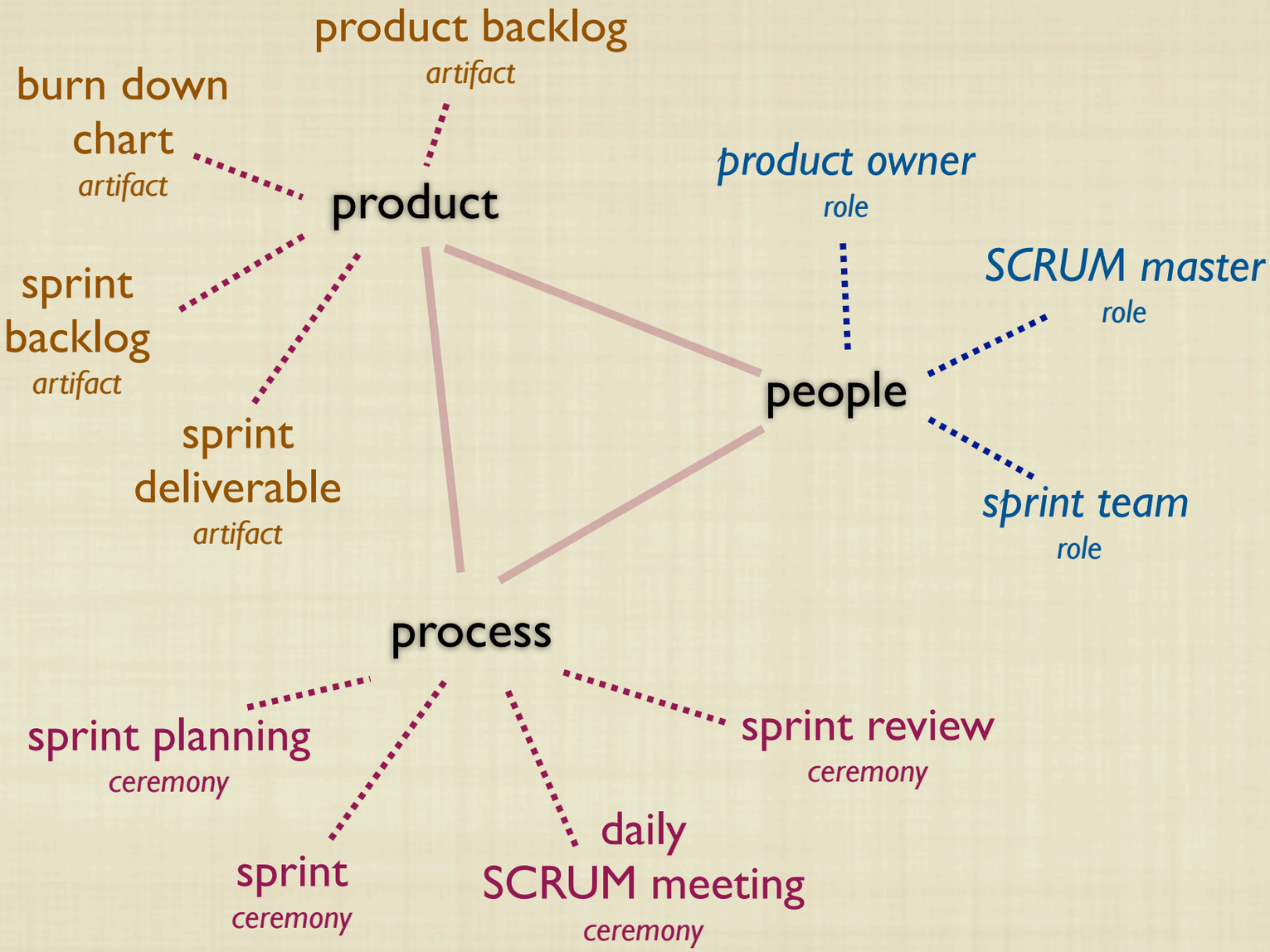
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  - ☑ agile methodology - SCRUM (HICSS-45)

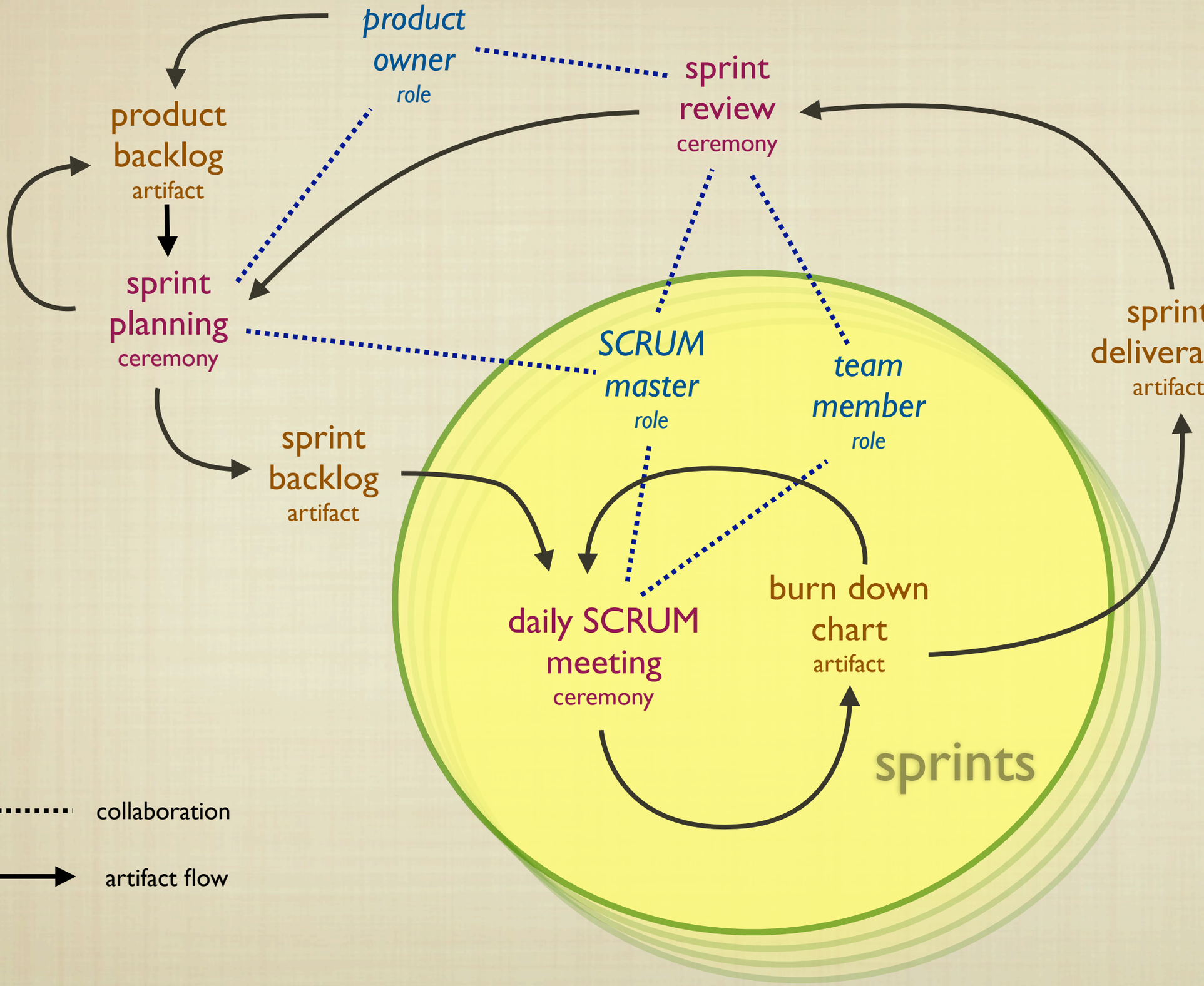
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SCRUM Ontology



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SCRUM Architecture



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- Other System Domains

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  - ☐ business process modeling
- Other System Domains
  - ☐ music

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  - ☑ agile methodology - SCRUM (HICSS-45)
  - ☐ business process modeling
- Other System Domains
  - ☐ music
  - ☐ english composition

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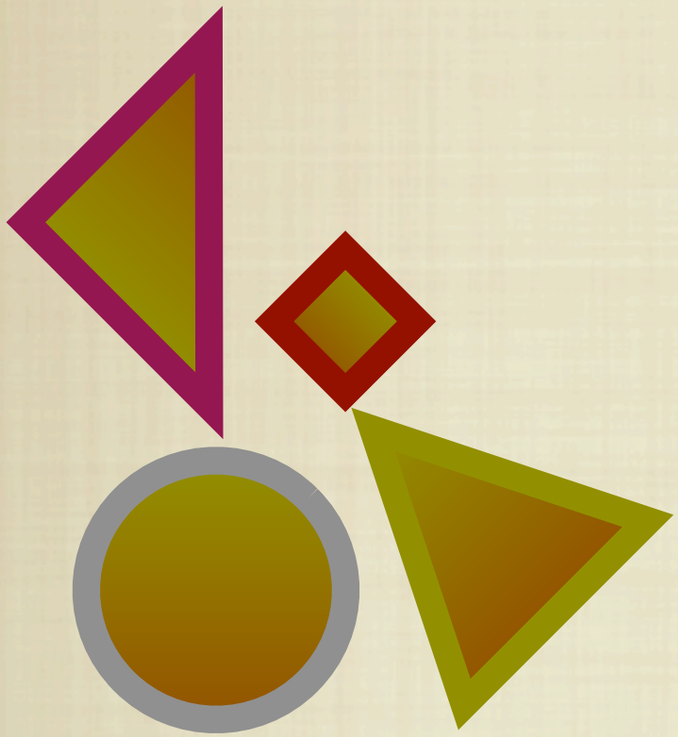
- Design (*vt*): The composition of deliberate formative decisions in the process of creating an artifact.

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The Design Process

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The Design Process

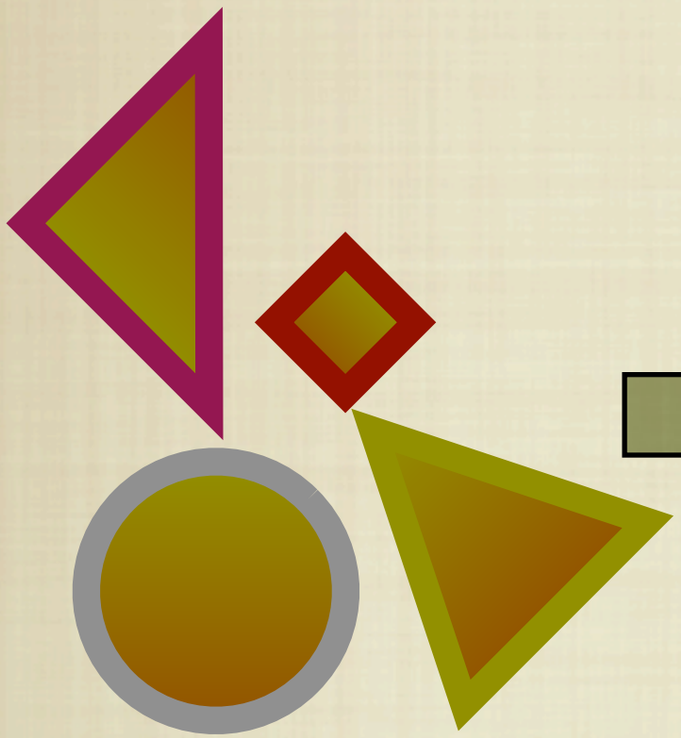


Stakeholder intensions
requirement elements
model elements
design elements

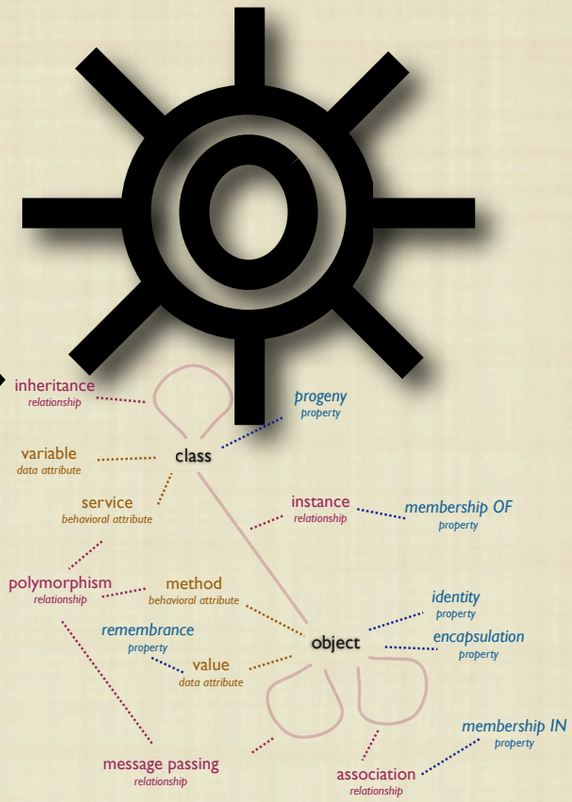
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The Design Process

"rules of thumb"
Traditional patterns



Stakeholder intensions
requirement elements
model elements
design elements

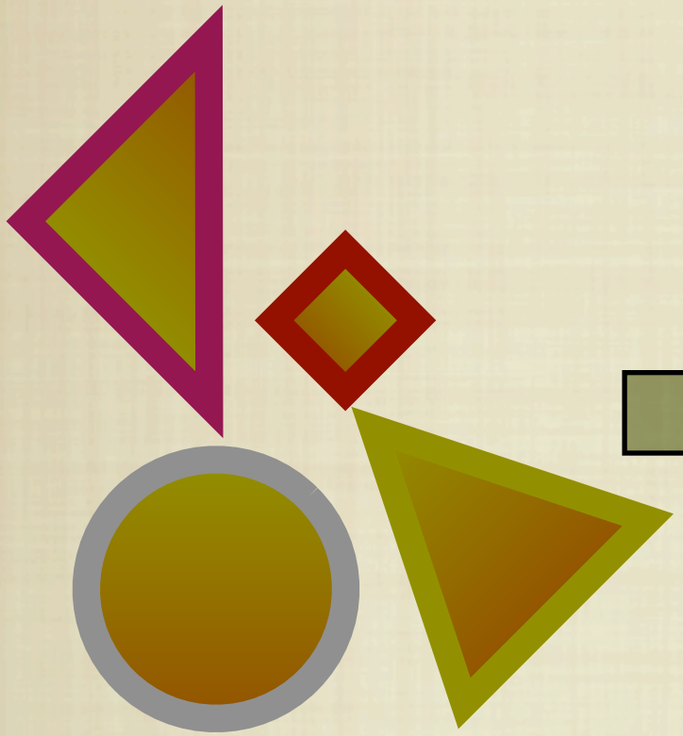


Representational
paradigm or Ontology

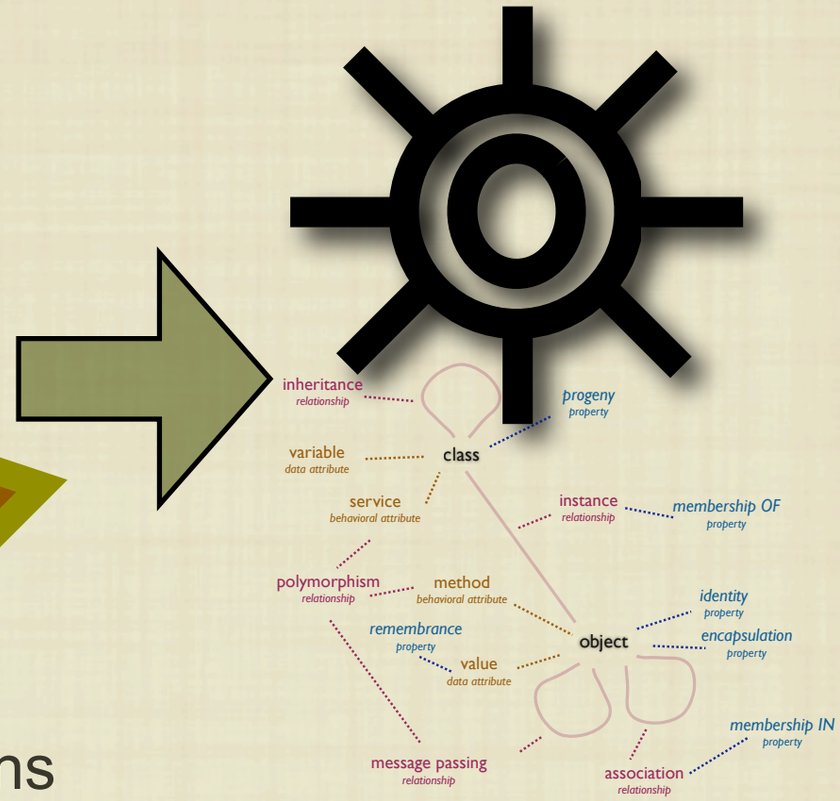
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The Design Process

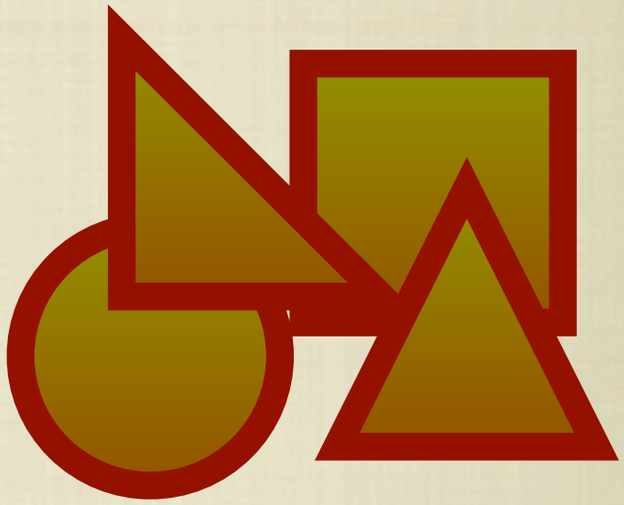
"rules of thumb"
Traditional patterns



Stakeholder intensions
requirement elements
model elements
design elements



Representational
paradigm or Ontology

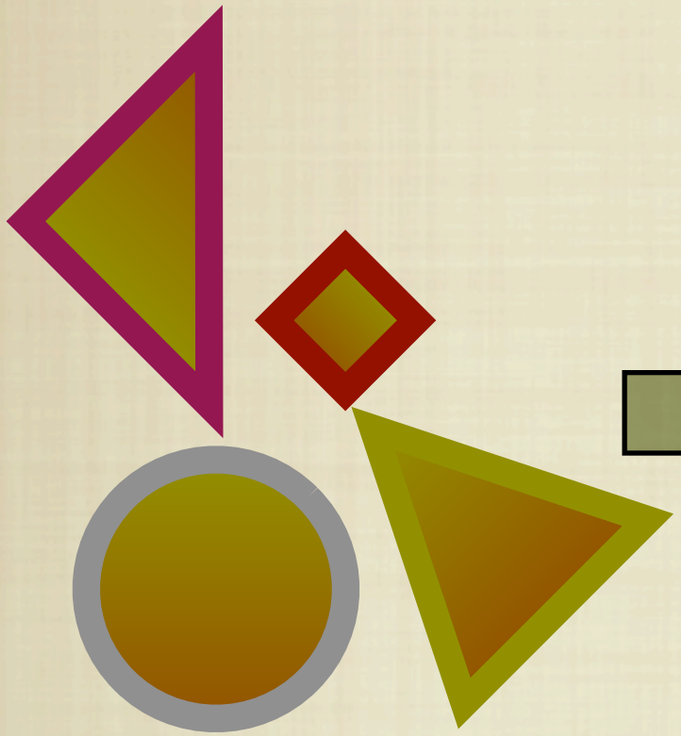


Resulting
Design
Elements

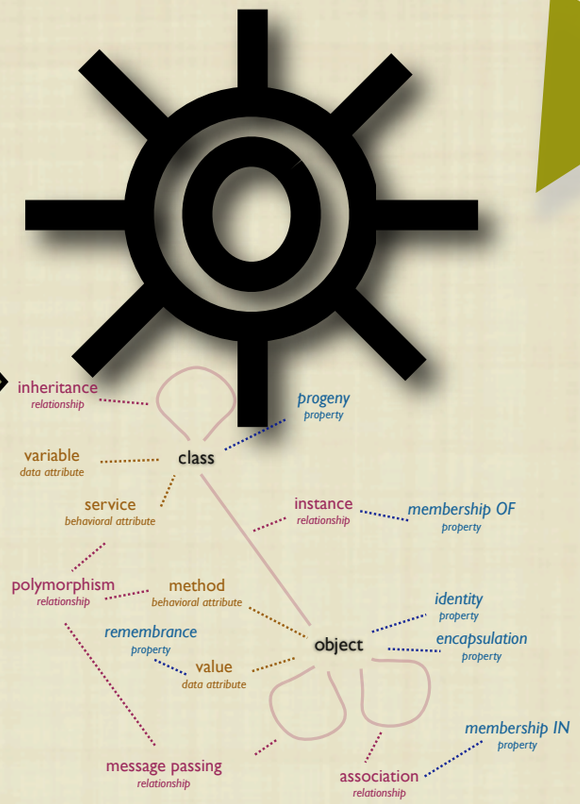
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The Design Process

"rules of thumb"
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Stakeholder intensions
requirement elements
model elements
design elements



Representational
paradigm or Ontology

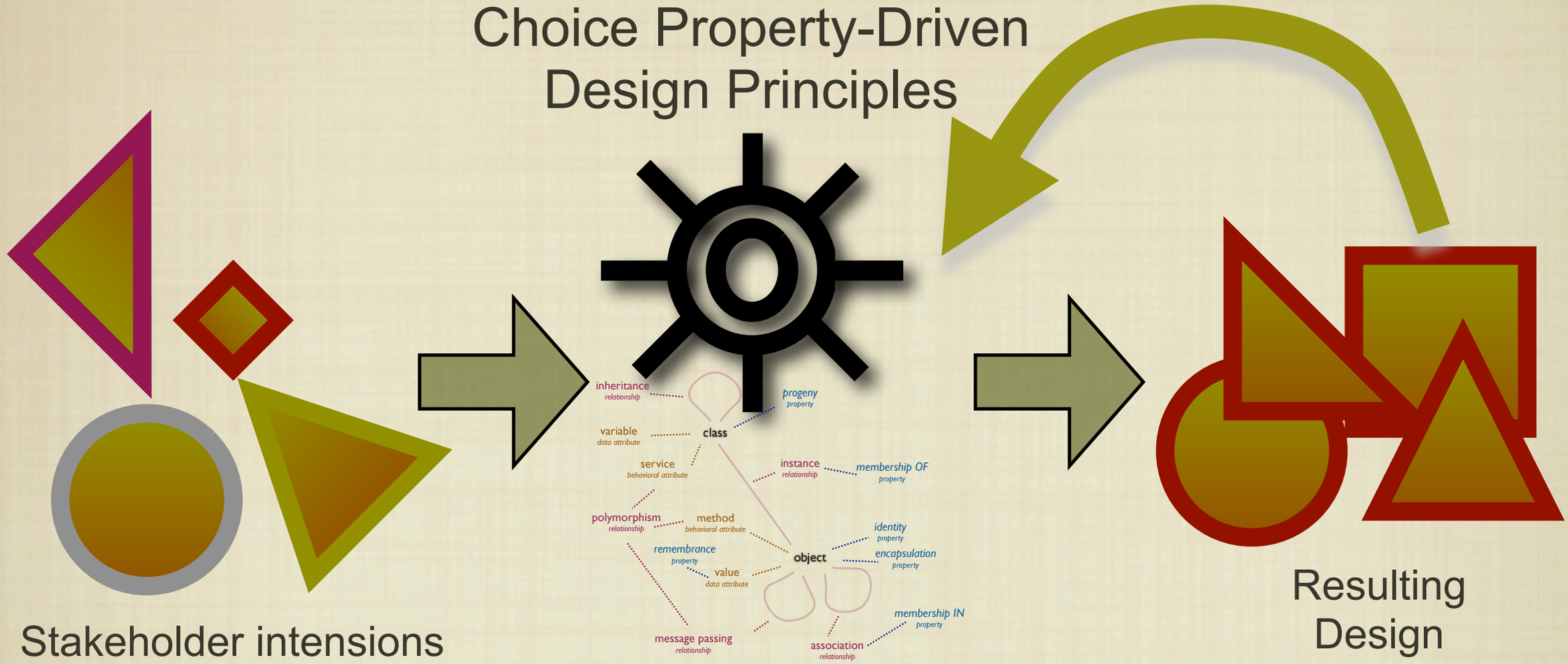


Resulting
Design
Elements

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The Design Process

Choice Property-Driven Design Principles



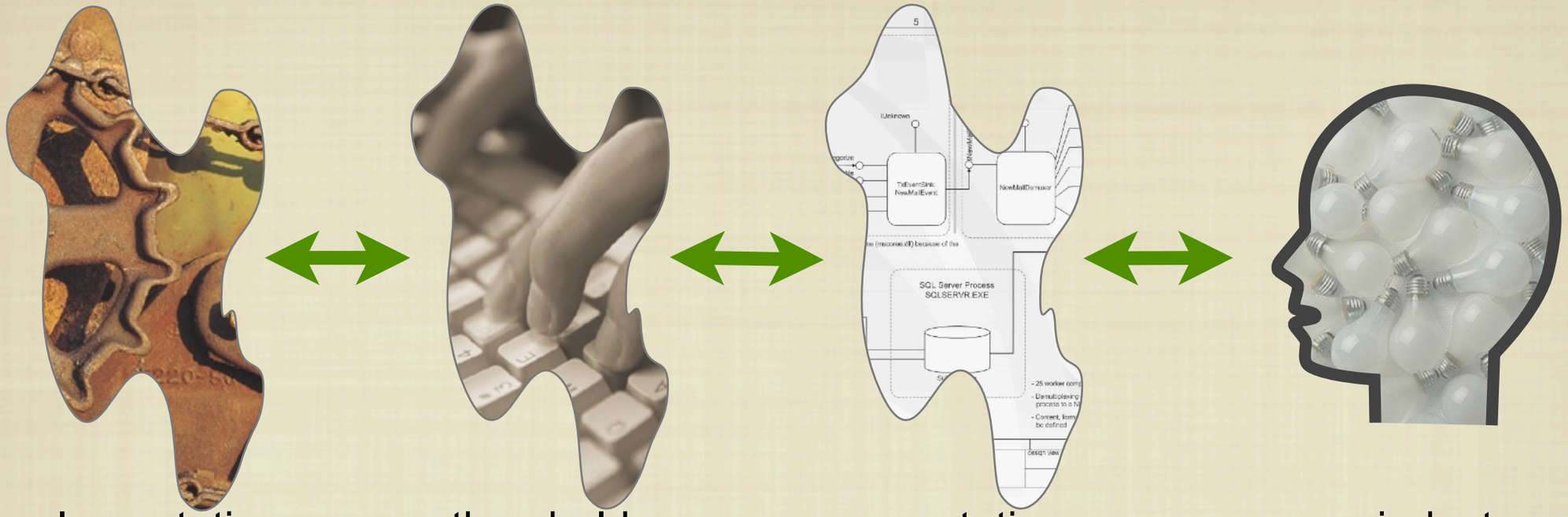
Stakeholder intensions
requirement elements
model elements
design elements

Representational paradigm or Ontology

Resulting Design Elements

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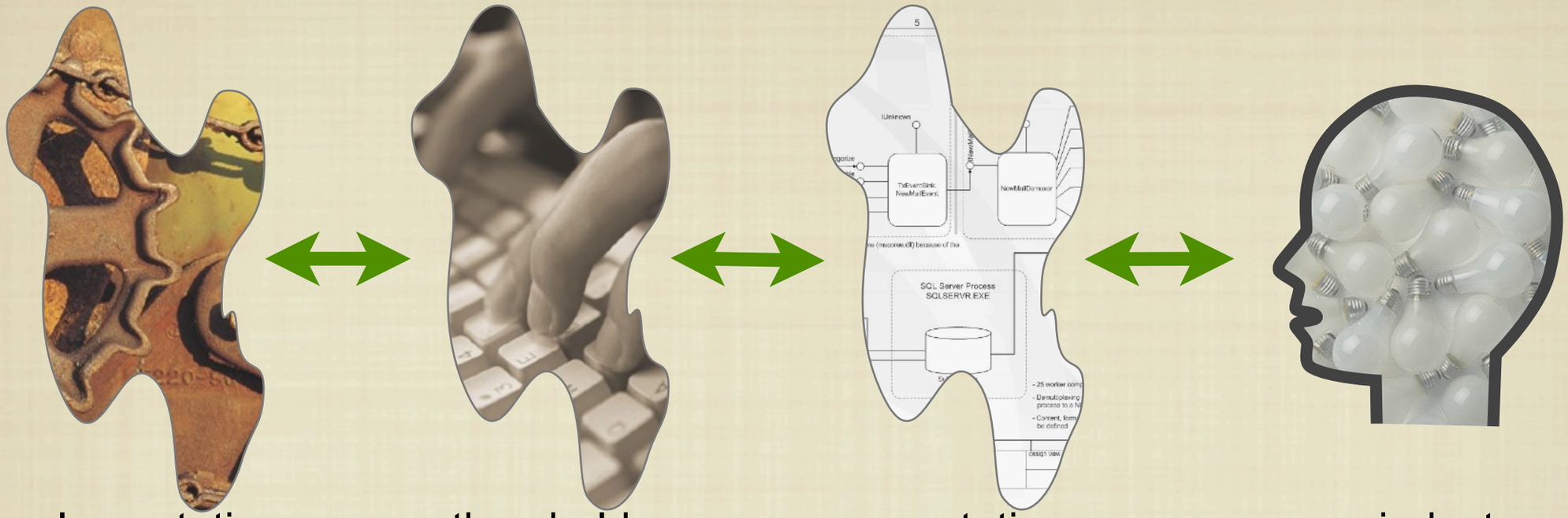
design quality across the system models



implementation threshold expectation mindset

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design quality across the system models

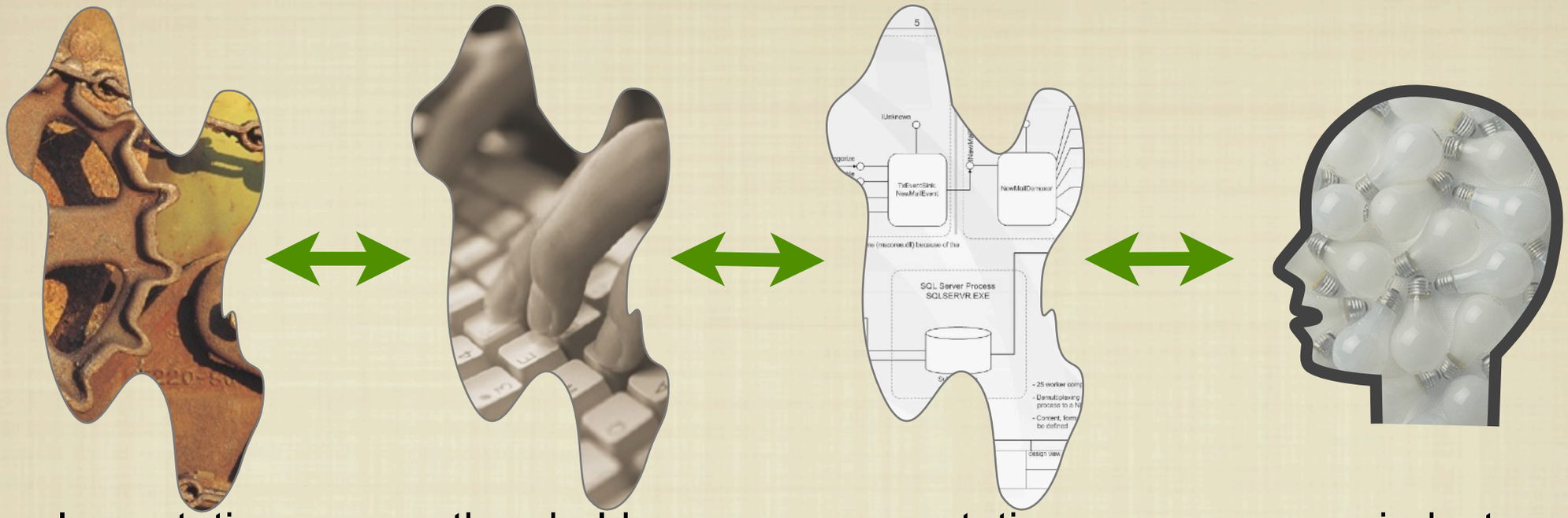


implementation threshold expectation mindset

Choice Property-Driven
Design Principles

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design quality across the system models



implementation

threshold

expectation

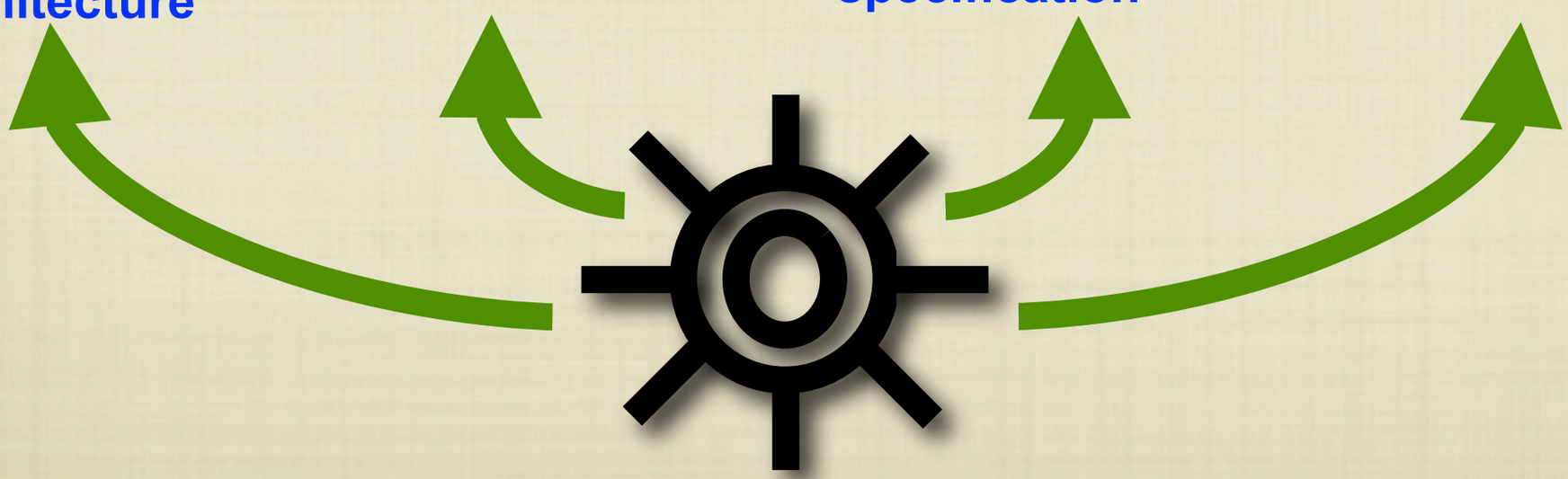
mindset

hardware & software architecture

interfaces

requirements engineering & specification

object oriented “systems think”

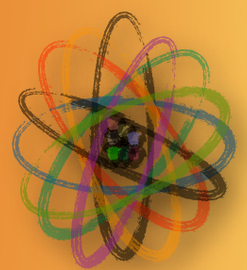


Choice Property-Driven Design Principles

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Pursuing a Universal Foundation of System Design Quality

from the
beauty in
nature

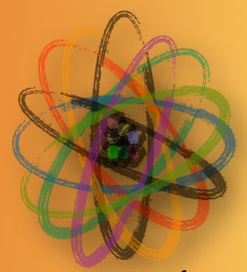


properties of
order in nature

to the
quality
in systems

Pursuing a Universal Foundation of System Design Quality

from the beauty in nature



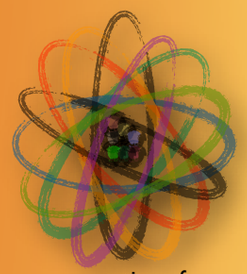
properties of order in nature

- Stepwise Refinement
- Modularization
- Cohesion
- Encapsulation
- Composition of Function
- Scale
- Correctness
- User Friendliness
- Extensibility
- Patterns
- Reliability
- Transparency
- Programmability
- Identity
- Elegance

to the quality in systems

Pursuing a Universal Foundation of System Design Quality

from the beauty in nature



properties of order in nature

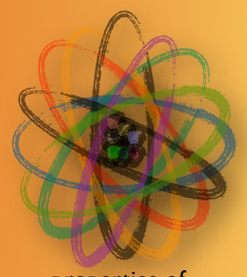
elaborate	Stepwise Refinement
modularize	Modularization
factor	Cohesion
encapsulate	Encapsulation
assemble	Composition of Function
focus	Scale
align	Correctness
accommodate	User Friendliness
extend	Extensibility
pattern	Patterns
normalize	Reliability
expose	Transparency
generalize	Programmability
identify	Identity
coordinate	Elegance

to the quality in systems

system design actions and choice properties

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properties of order in nature

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modularize

factor

encapsulate

assemble

focus

align

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extend

pattern

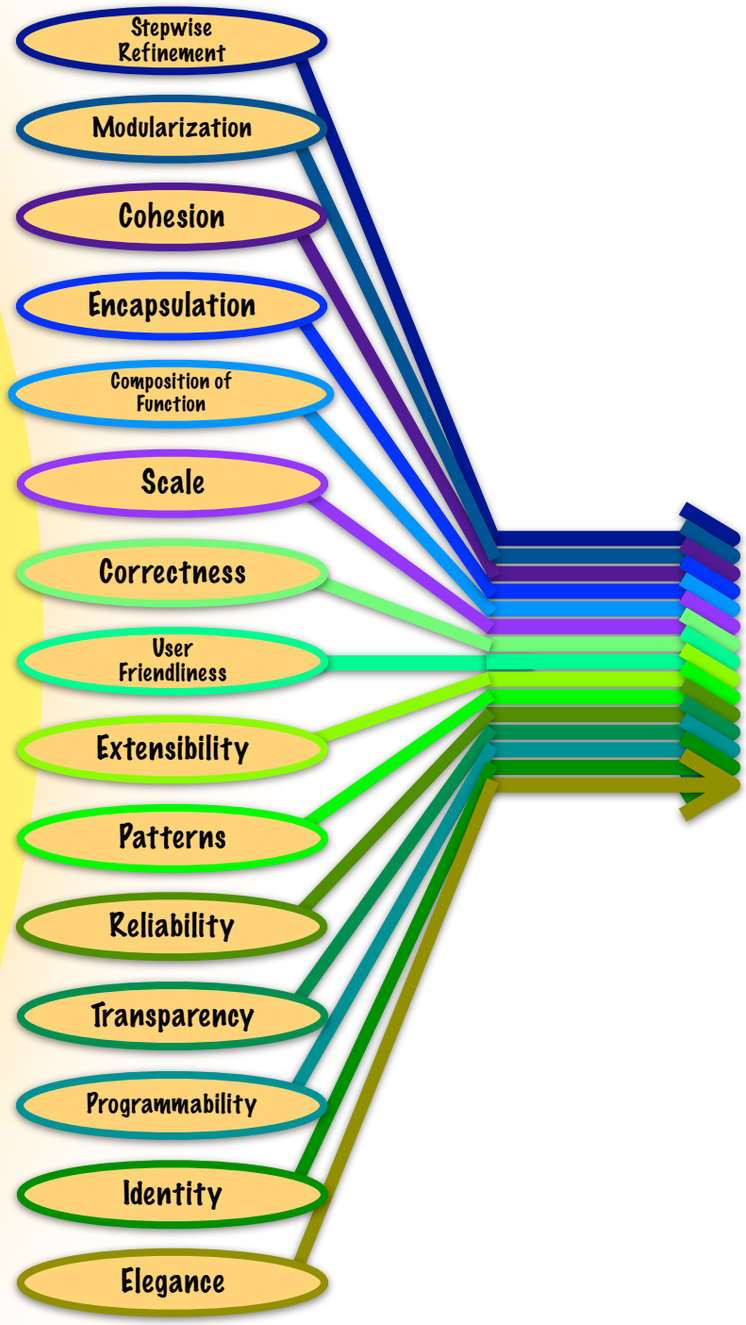
normalize

expose

generalize

identify

coordinate

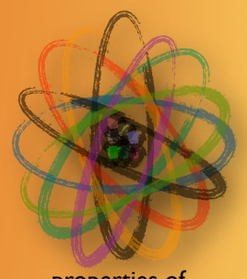


to the quality in systems

system design actions and choice properties

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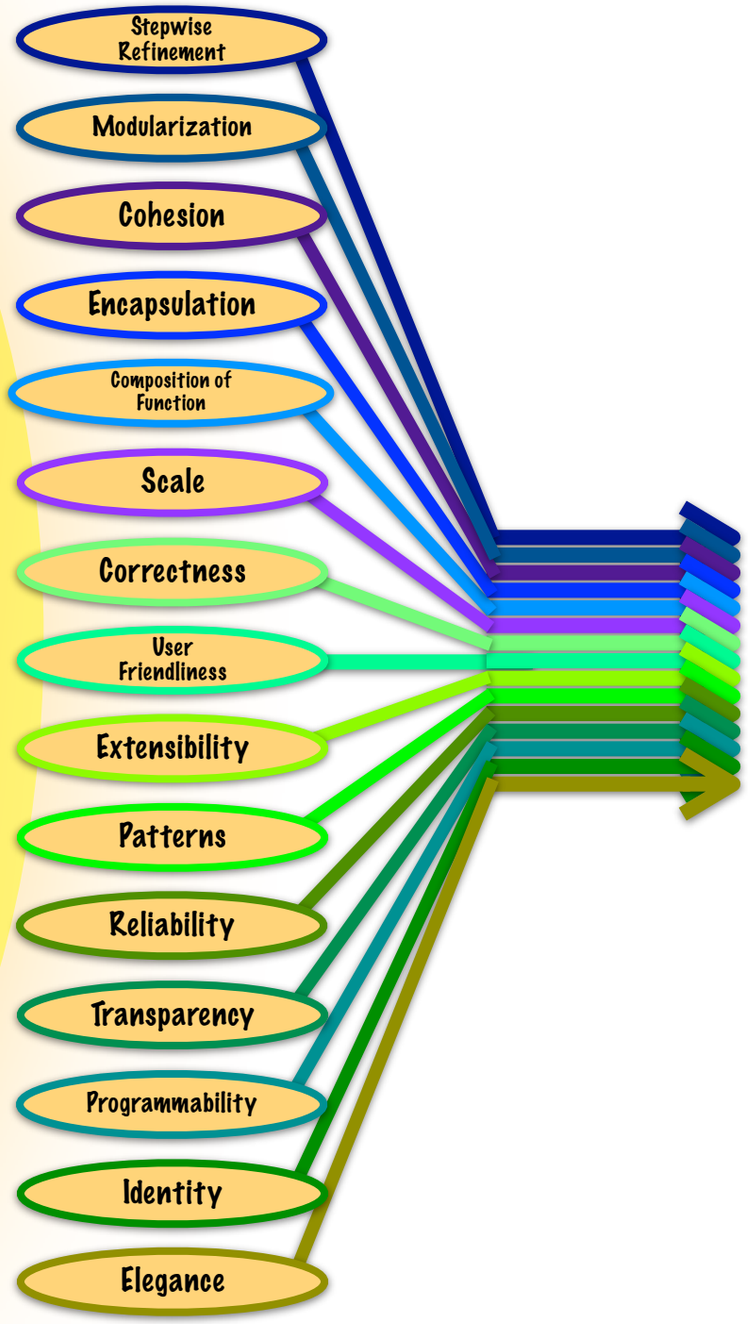
normalize

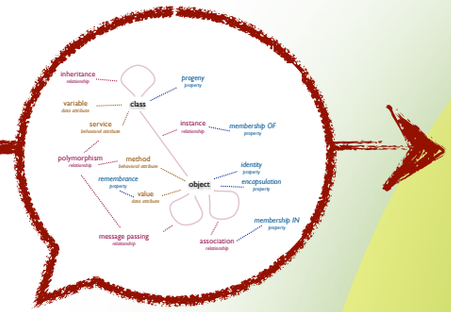
expose

generalize

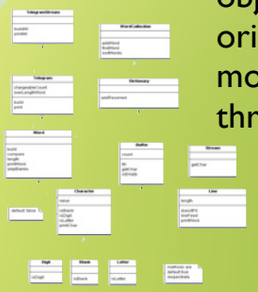
identify

coordinate





Object-oriented ontology



object-oriented models that thrive

to the quality in systems

system design actions and choice properties

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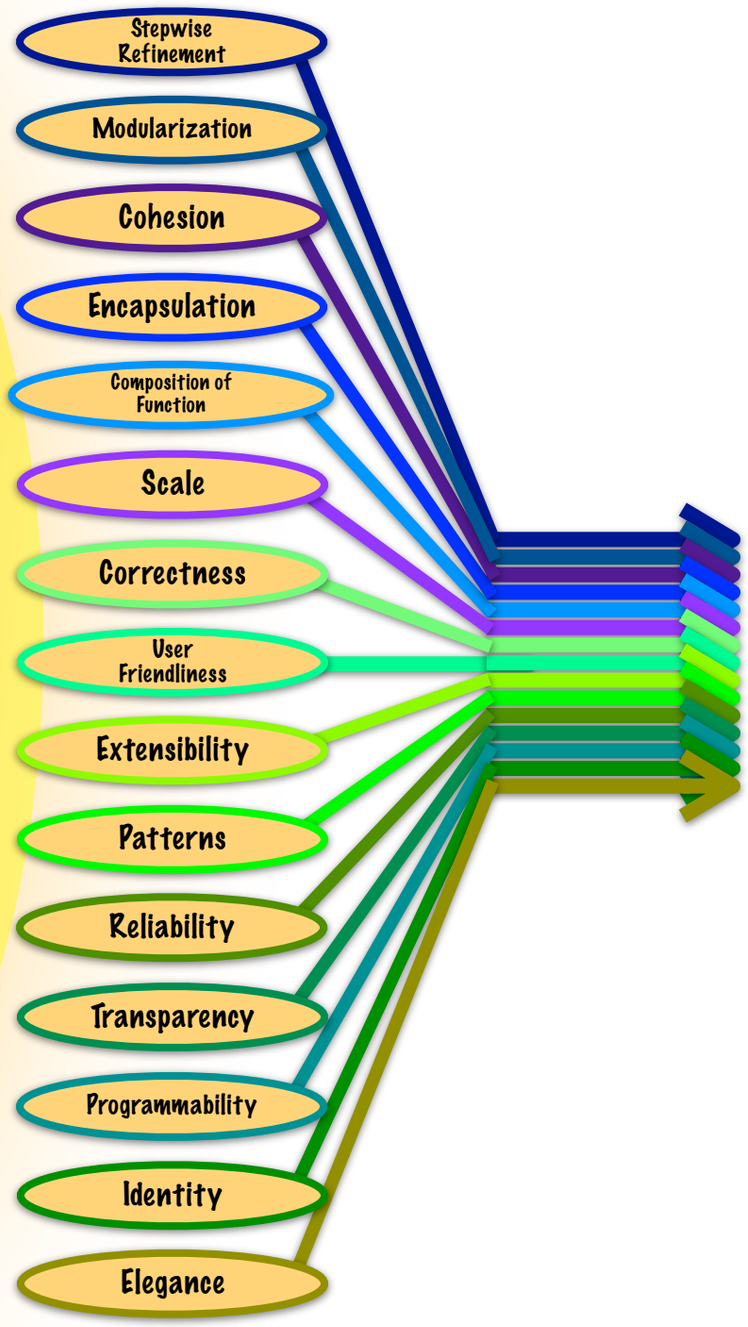
normalize

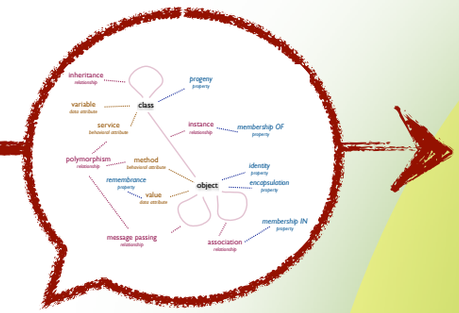
expose

generalize

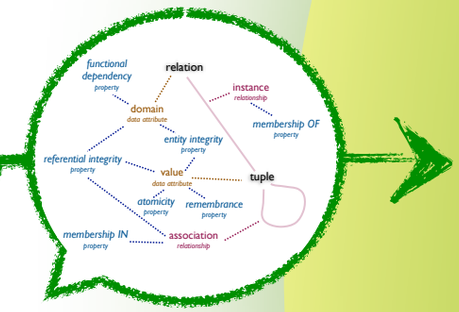
identify

coordinate

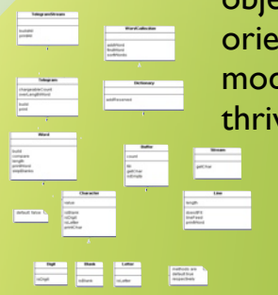




Object-oriented ontology

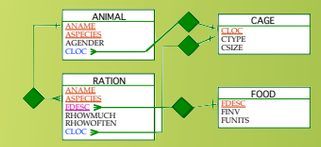


Relational data ontology



object-oriented models that thrive

to the quality in systems

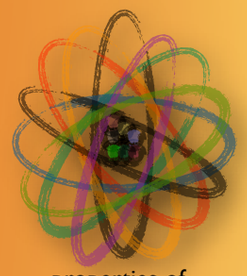


relational data models that thrive

system design actions and choice properties

Pursuing a Universal Foundation of System Design Quality

from the beauty in nature



properties of order in nature

elaborate

modularize

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encapsulate

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Stepwise Refinement

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Encapsulation

Composition of Function

Scale

Correctness

User Friendliness

Extensibility

Patterns

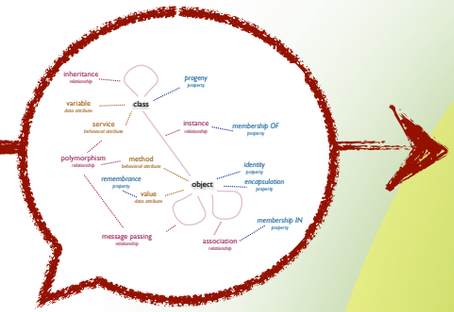
Reliability

Transparency

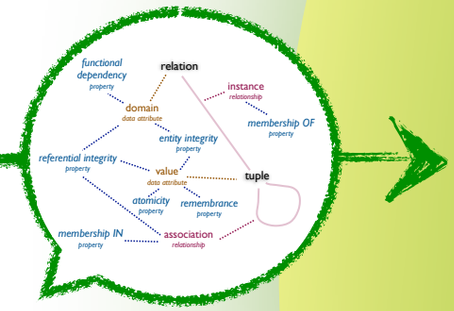
Programmability

Identity

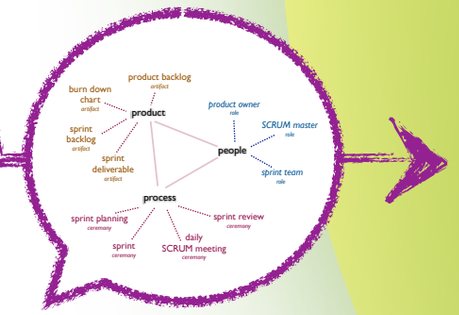
Elegance



Object-oriented ontology



Relational data ontology

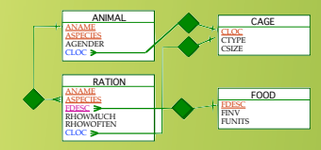


SCRUM ontology

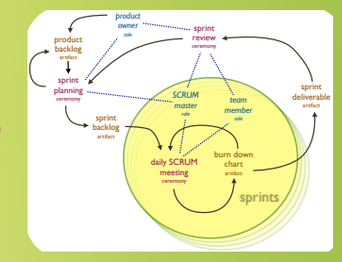
to the quality in systems



object-oriented models that thrive



relational data models that thrive

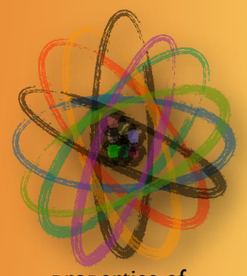


agile project management models that thrive

system design actions and choice properties

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assemble

focus

align

accommodate

extend

pattern

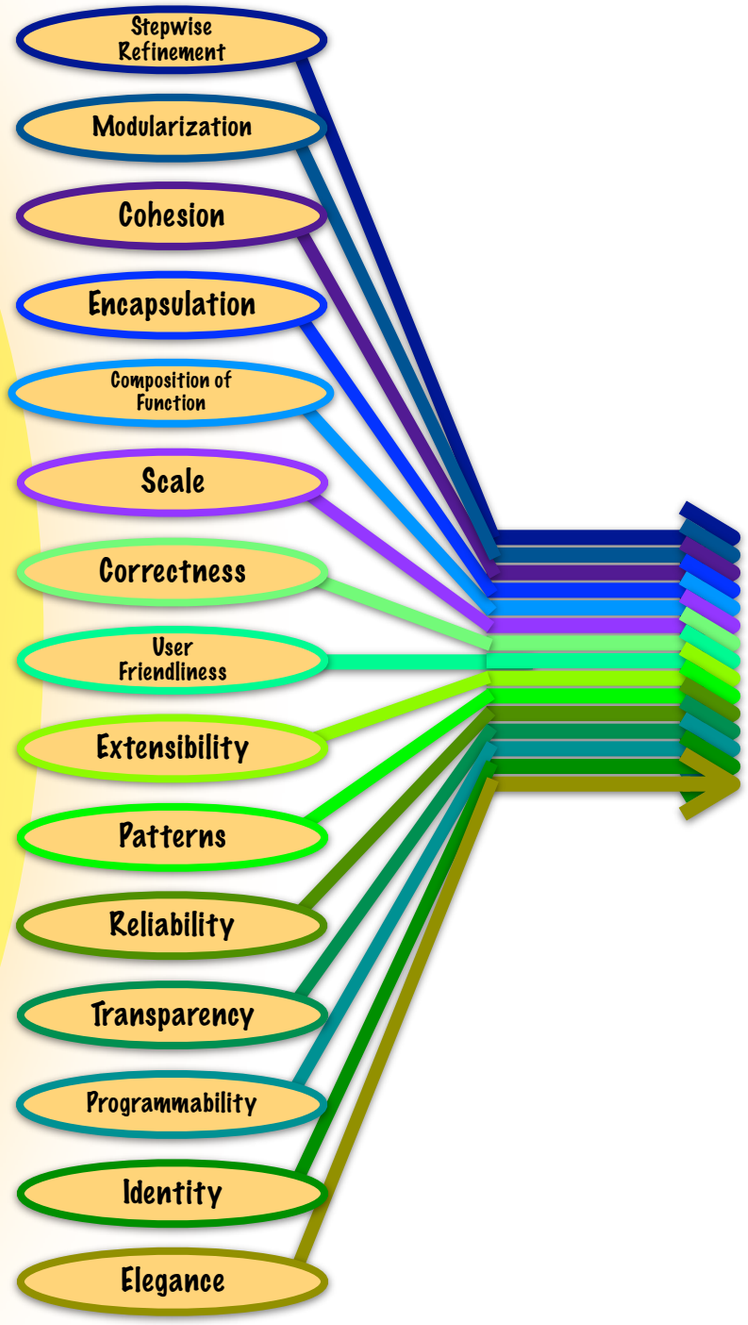
normalize

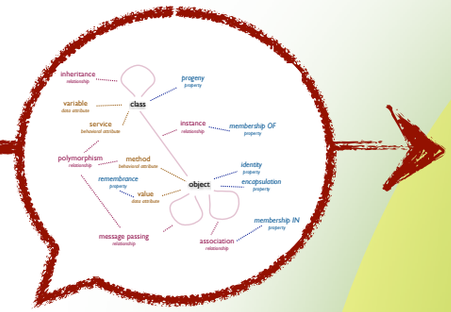
expose

generalize

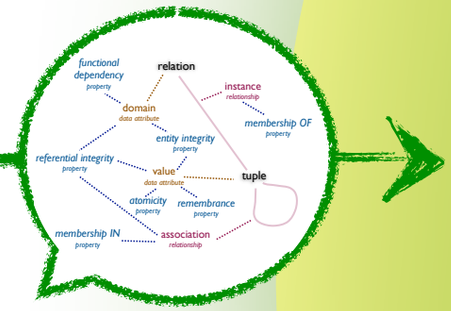
identify

coordinate

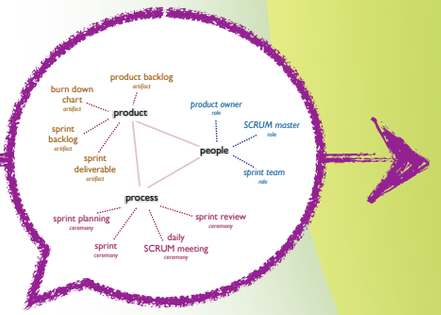




Object-oriented ontology



Relational data ontology

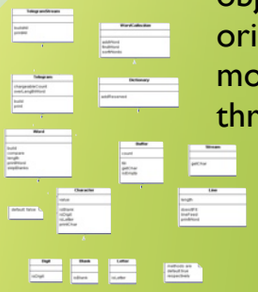


SCRUM ontology

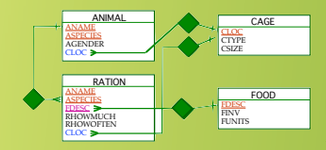


Business process modeling vocabulary or ontology?

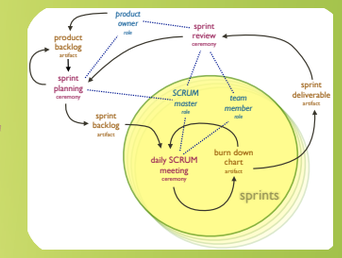
object-oriented models that thrive



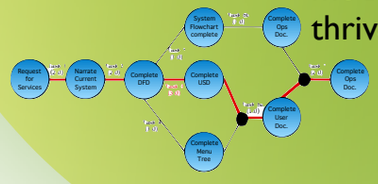
relational data models that thrive



agile project management models that thrive



business models that thrive ??



system design actions and choice properties

Toward a Vision of Thriving Systems

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Toward a Vision of Thriving Systems

- ***"The Nature of Order"*** is evident in choice properties observable in information systems!

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Toward a Vision of Thriving Systems

- ***"The Nature of Order"*** is evident in choice properties observable in information systems!
- The translated properties denote design features that may appear to be discrete.

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Toward a Vision of Thriving Systems

- ***"The Nature of Order"*** is evident in choice properties observable in information systems!
- The translated properties denote design features that may appear to be discrete.
- Might property strength and interaction resonate as quality?

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Toward a Vision of Thriving Systems

- ***"The Nature of Order"*** is evident in choice properties observable in information systems!
- The translated properties denote design features that may appear to be discrete.
- Might property strength and interaction resonate as quality?
- Might a taxonomy of quality emerge?

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Choice Properties

2. Cohesion

1. Stepwise Refinement

3. Encapsulation

5. Modularization

8. Composition of Function

10. Scale

7. Transparency

11. User Friendliness

13. Programmability

12. Patterns

6. Correctness

15. Elegance

9. Identity

14. Reliability

4. Extensibility

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Property Interaction

	Alexander's Property Support Intersection Row item supported by column	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Levels of Scale															
2	Strong Centers															
3	Boundaries															
4	Alternating Repetition															
5	Positive Space															
6	Good Shape															
7	Local Symmetries															
8	Deep Interlock and Ambiguity															
9	Contrast															
10	Gradients															
11	Roughness															
12	Echoes															
13	The Void															
14	Simplicity and Inner Calm															
15	Not Separateness															

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Property Interaction

	Alexander's Property Support Intersection Row item supported by column	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Levels of Scale		•	•			•			•						
2	Strong Centers				•			•		•	•			•		•
3	Boundaries		•		•			•	•	•	•					
4	Alternating Repetition		•			•	•		•	•						•
5	Positive Space	•	•	•			•	•		•		•		•		
6	Good Shape	•	•			•			•		•		•		•	
7	Local Symmetries	•				•				•				•		
8	Deep Interlock and Ambiguity				•	•				•		•	•			•
9	Contrast			•		•			•		•			•		•
10	Gradients	•	•					•		•		•	•			•
11	Roughness		•			•	•				•				•	•
12	Echoes	•					•	•			•	•				•
13	The Void	•		•		•		•		•					•	
14	Simplicity and Inner Calm						•	•					•	•		•
15	Not Separateness			•		•			•		•	•		•	•	

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Property Interaction

	Alexander's Property Support Intersection Row item supported by column	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Levels of Scale		•	•			•			•						
2	Strong Centers				•			•		•	•			•		•
3	Boundaries		•		•			•	•	•	•					
4	Alternating Repetition		•			•	•		•	•						•
5	Positive Space	•	•	•			•	•		•		•		•		
6	Good Shape	•	•			•			•		•		•		•	
7	Local Symmetries	•				•				•				•		
8	Deep Interlock and Ambiguity				•	•				•		•	•			•
9	Contrast			•		•			•		•			•		•
10	Gradients	•	•					•		•		•	•			•
11	Roughness		•			•	•				•				•	•
12	Echoes	•					•	•			•	•				•
13	The Void	•		•		•		•		•					•	
14	Simplicity and Inner Calm						•	•					•	•		•
15	Not Separateness			•		•			•		•	•		•	•	

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Property Interaction

	Alexander's Property Support Intersection Row item supported by column	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Levels of Scale		•	•			•			•						
2	Strong Centers				•			•		•	•			•		•
3	Boundaries		•		•			•	•	•	•					
4	Alternating Repetition		•			•	•		•	•						•
5	Positive Space	•	•	•			•	•		•		•		•		
6	Good Shape	•	•			•			•		•		•		•	
7	Local Symmetries	•				•				•				•		
8	Deep Interlock and Ambiguity				•	•				•		•	•			•
9	Contrast			•		•			•		•			•		•
10	Gradients	•	•					•		•		•	•			•
11	Roughness		•			•	•				•				•	•
12	Echoes	•					•	•			•	•				•
13	The Void	•		•		•		•		•					•	
14	Simplicity and Inner Calm						•	•					•	•		•
15	Not Separateness			•		•			•		•	•		•	•	

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Alexander's Inter-Property Support Network

Levels of Scale

Not Separateness

Positive Space

Contrast

Strong Centers

The Void

Boundaries

Local Symmetries

Deep Interlock and Ambiguity

Simplicity and Inner Calm

Gradients

Echoes

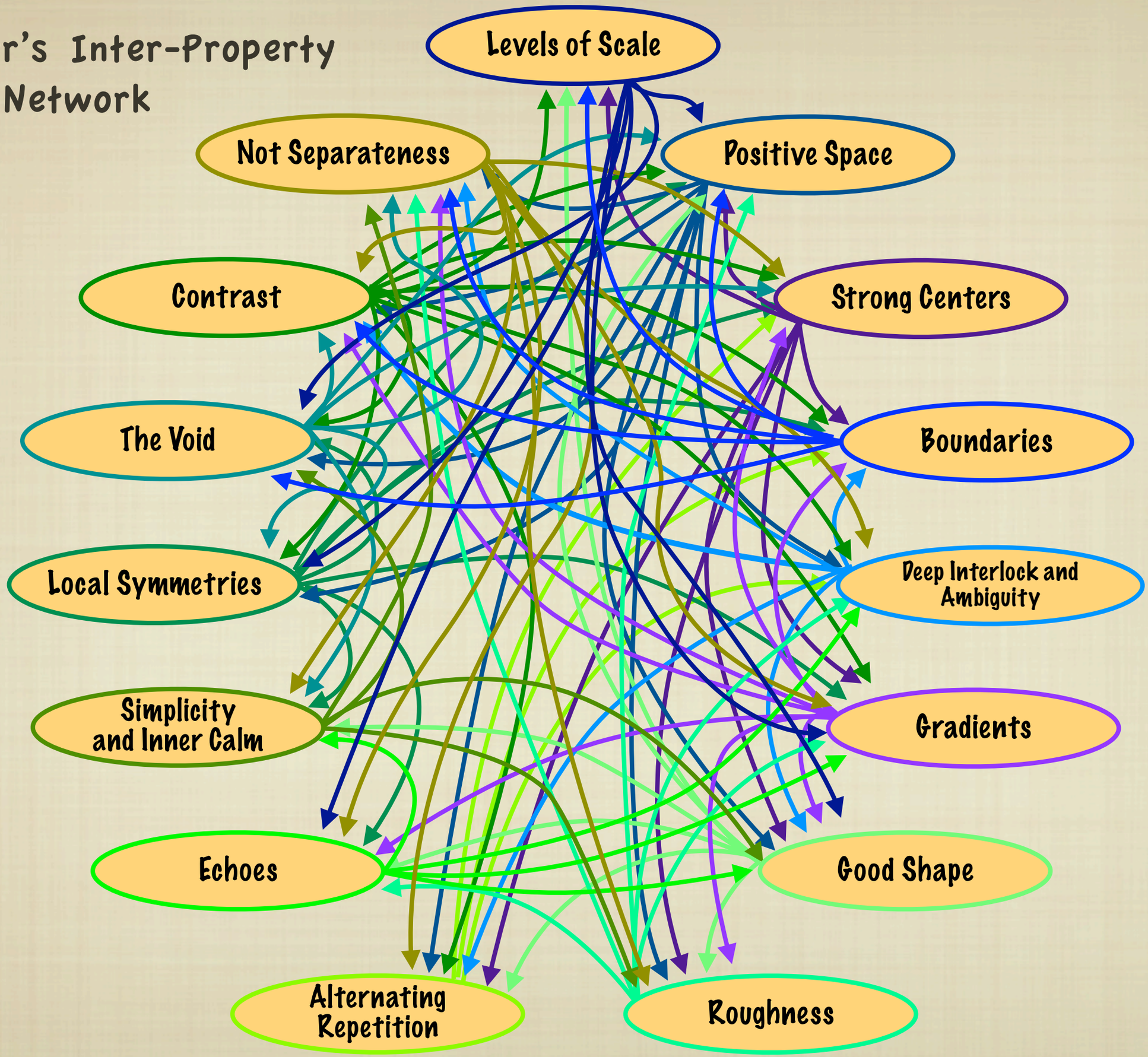
Good Shape

Alternating Repetition

Roughness

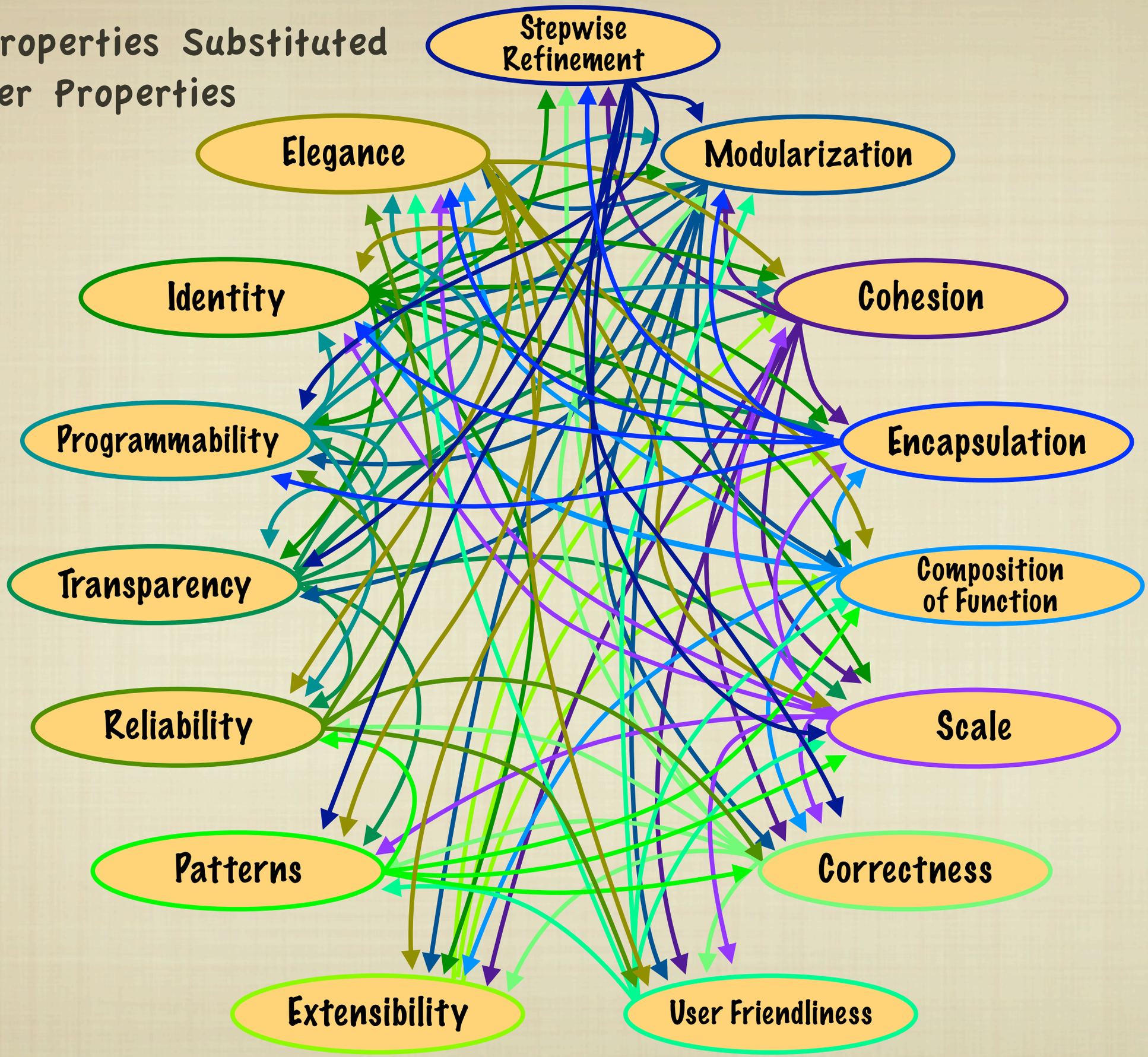
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Alexander's Inter-Property Support Network



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Choice Properties Substituted for Center Properties



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Coherence Analysis

Center Properties		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Levels of Scale	1	0.00														
Strong Centers	2	1.58	0.00													
Boundaries	3	1.17	0.67	0.00												
Alternating Repetition	4	0.75	1.33	1.00	0.00											
Positive Space	5	0.50	1.13	1.13	1.13	0.00										
Good Shape	6	1.25	1.71	1.13	0.83	1.25	0.00									
Local Symmetries	7	1.50	1.17	1.58	1.17	0.88	1.25	0.00								
Deep Interlock and Ambiguity	8	1.58	1.00	1.33	1.00	1.42	1.42	1.17	0.00							
Contrast	9	1.58	1.00	1.33	1.00	1.42	1.13	1.17	1.33	0.00						
Gradients	10	1.21	1.07	1.07	1.07	0.66	1.20	1.21	0.76	1.69	0.00					
Roughness	11	1.17	1.33	1.33	0.67	1.42	0.54	1.58	1.33	1.00	1.38	0.00				
Echoes	12	1.58	1.00	1.33	1.33	0.83	1.13	1.58	1.33	1.33	0.76	1.00	0.00			
The Void	13	1.17	1.33	1.33	1.33	0.83	1.13	0.75	1.33	1.33	1.07	1.33	1.33	0.00		
Simplicity and Inner Calm	14	1.55	0.90	1.63	1.27	1.03	1.35	1.55	1.27	1.27	0.97	1.27	0.90	1.63	0.00	
Not Separateness	15	1.61	1.38	1.38	1.38	1.20	0.93	1.21	1.38	0.45	1.71	1.07	1.38	1.07	1.66	0.00

Coherence is the sum of the fraction of supporting properties that mutually overlap between two properties ($0 \leq ç \leq 2$). The distance is (2 - ç).

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Coherence Analysis

Choice Properties		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Stepwise Refinement	1	0.00														
Cohesion	2	1.58	0.00													
Encapsulation	3	1.17	0.67	0.00												
Extensibility	4	0.75	1.33	1.00	0.00											
Modularization	5	0.50	1.13	1.13	1.13	0.00										
Correctness	6	1.25	1.71	1.13	0.83	1.25	0.00									
Transparency	7	1.50	1.17	1.58	1.17	0.88	1.25	0.00								
Composition of Function	8	1.58	1.00	1.33	1.00	1.42	1.42	1.17	0.00							
Identity	9	1.58	1.00	1.33	1.00	1.42	1.13	1.17	1.33	0.00						
Scale	10	1.21	1.07	1.07	1.07	0.66	1.20	1.21	0.76	1.69	0.00					
User Friendliness	11	1.17	1.33	1.33	0.67	1.42	0.54	1.58	1.33	1.00	1.38	0.00				
Patterns	12	1.58	1.00	1.33	1.33	0.83	1.13	1.58	1.33	1.33	0.76	1.00	0.00			
Programmability	13	1.17	1.33	1.33	1.33	0.83	1.13	0.75	1.33	1.33	1.07	1.33	1.33	0.00		
Reliability	14	1.55	0.90	1.63	1.27	1.03	1.35	1.55	1.27	1.27	0.97	1.27	0.90	1.63	0.00	
Elegance	15	1.61	1.38	1.38	1.38	1.20	0.93	1.21	1.38	0.45	1.71	1.07	1.38	1.07	1.66	0.00

Coherence is the sum of the fraction of supporting properties that mutually overlap between two properties ($0 \leq ç \leq 2$). The distance is (2 - ç).

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Choice Properties

2. Cohesion

13. Programmability

1. Stepwise Refinement

3. Encapsulation

5. Modularization

8. Composition of Function

10. Scale

7. Transparency

11. User Friendliness

12. Patterns

6. Correctness

15. Elegance

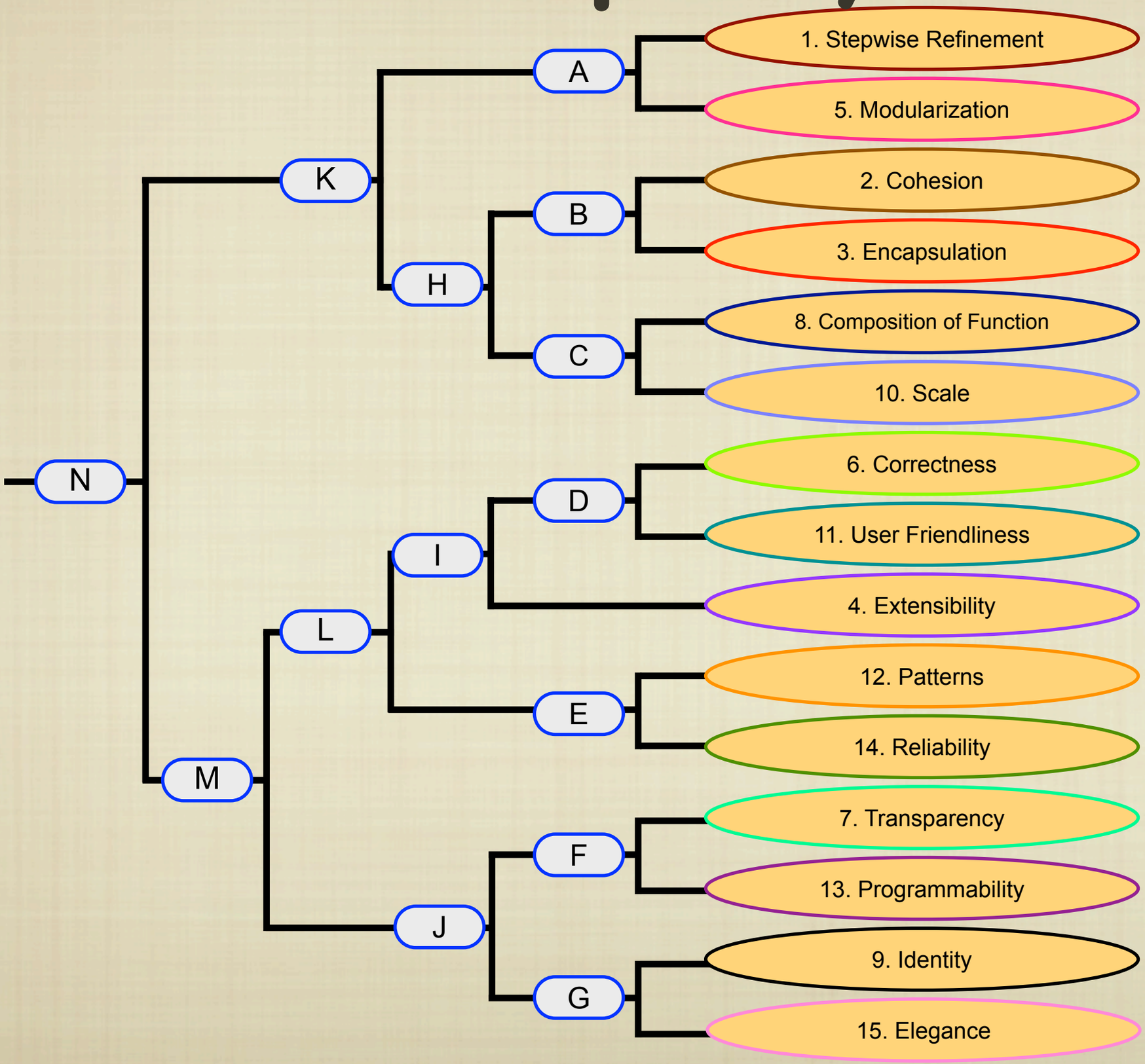
9. Identity

14. Reliability

4. Extensibility

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Choice Property Clusters



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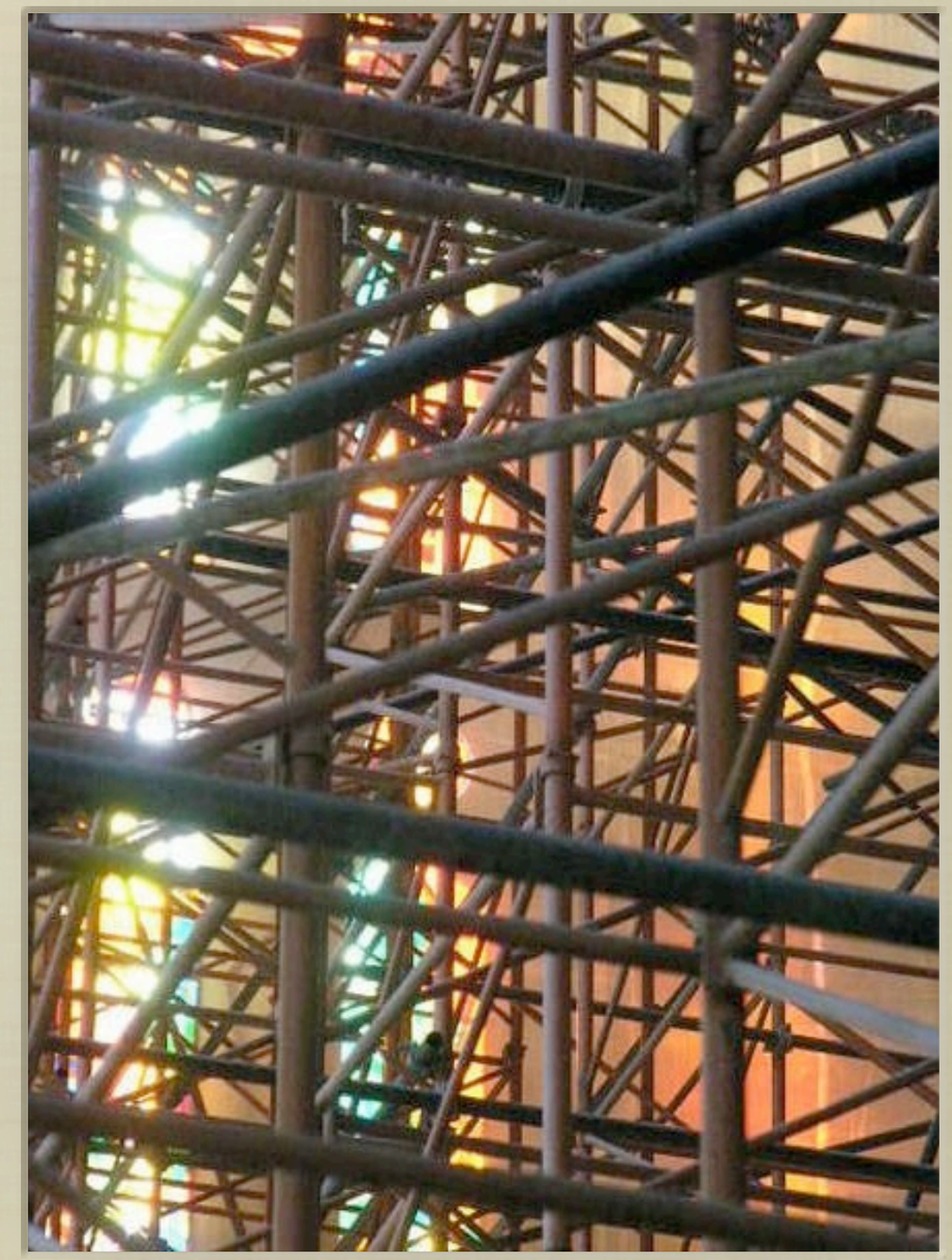
Clusters with Supporting Properties

			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A	1	Stepwise Refinement		2	3			6			9						
	5	Modularization	1	2	3			6	7		9		11		13		
B	2	Cohesion				4			7		9	10			13		15
	3	Encapsulation		2		4			7	8	9	10					
C	8	Composition of Function				4	5			8	9		11	12			15
	10	Scale	1	2					7		9		11	12			15
D	6	Correctness	1	2			5	6		8		10		12		14	
	11	User Friendliness		2			5	6				10				14	15
E	12	Patterns	1					6	7			10	11				15
	14	Reliability						6	7					12	13		15
F	7	Transparency	1				5				9				13		
	13	Programmability	1		3		5		7		9					14	
G	9	Identity			3		5			8	9	10			13		15
	15	Elegance			3		5			8		10	11		13	14	
H	2	Cohesion				4			7		9	10			13		15
	3	Encapsulation		2		4			7	8	9	10					
	8	Composition of Function				4	5			8	9		11	12			15
	10	Scale	1	2					7		9		11	12			15
I	4	Extensibility		2			5	6		8	9						15
	6	Correctness	1	2			5	6		8		10		12		14	
	11	User Friendliness		2			5	6				10				14	15
J	7	Transparency	1				5				9				13		
	9	Identity			3		5			8	9	10			13		15
	13	Programmability	1		3		5		7		9					14	
	15	Elegance			3		5			8		10	11		13	14	

			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
K	1	Stepwise Refinement		2	3			6			9						
	2	Cohesion				4			7		9	10			13		15
	3	Encapsulation		2		4			7	8	9	10					
	5	Modularization	1	2	3			6	7		9		11		13		
	8	Composition of Function				4	5			8	9		11	12			15
	10	Scale	1	2					7		9		11	12			15
L	4	Extensibility		2			5	6		8	9						15
	6	Correctness	1	2			5	6		8		10		12		14	
	11	User Friendliness		2			5	6				10				14	15
	12	Patterns	1					6	7			10	11				15
	14	Reliability						6	7					12	13		15
M	4	Extensibility		2			5	6		8	9						15
	6	Correctness	1	2			5	6		8		10		12		14	
	7	Transparency	1				5				9				13		
	9	Identity			3		5			8	9	10			13		15
	11	User Friendliness		2			5	6				10				14	15
	12	Patterns	1					6	7			10	11				15
	13	Programmability	1		3		5		7		9					14	
	14	Reliability						6	7					12	13		15
	15	Elegance			3		5			8		10	11		13	14	
N	1	Stepwise Refinement		2	3			6			9						
	2	Cohesion				4			7		9	10			13		15
	3	Encapsulation		2		4			7	8	9	10					
	4	Extensibility		2			5	6		8	9						15
	5	Modularization	1	2	3			6	7		9		11		13		
	6	Correctness	1	2			5	6		8		10		12		14	
	7	Transparency	1				5				9				13		
	8	Composition of Function				4	5			8	9		11	12			15
	9	Identity			3		5			8	9	10			13		15
	10	Scale	1	2					7		9		11	12			15
	11	User Friendliness		2			5	6				10				14	15
	12	Patterns	1					6	7			10	11				15
	13	Programmability	1		3		5		7		9					14	
	14	Reliability						6	7					12	13		15
	15	Elegance			3		5			8		10	11		13	14	

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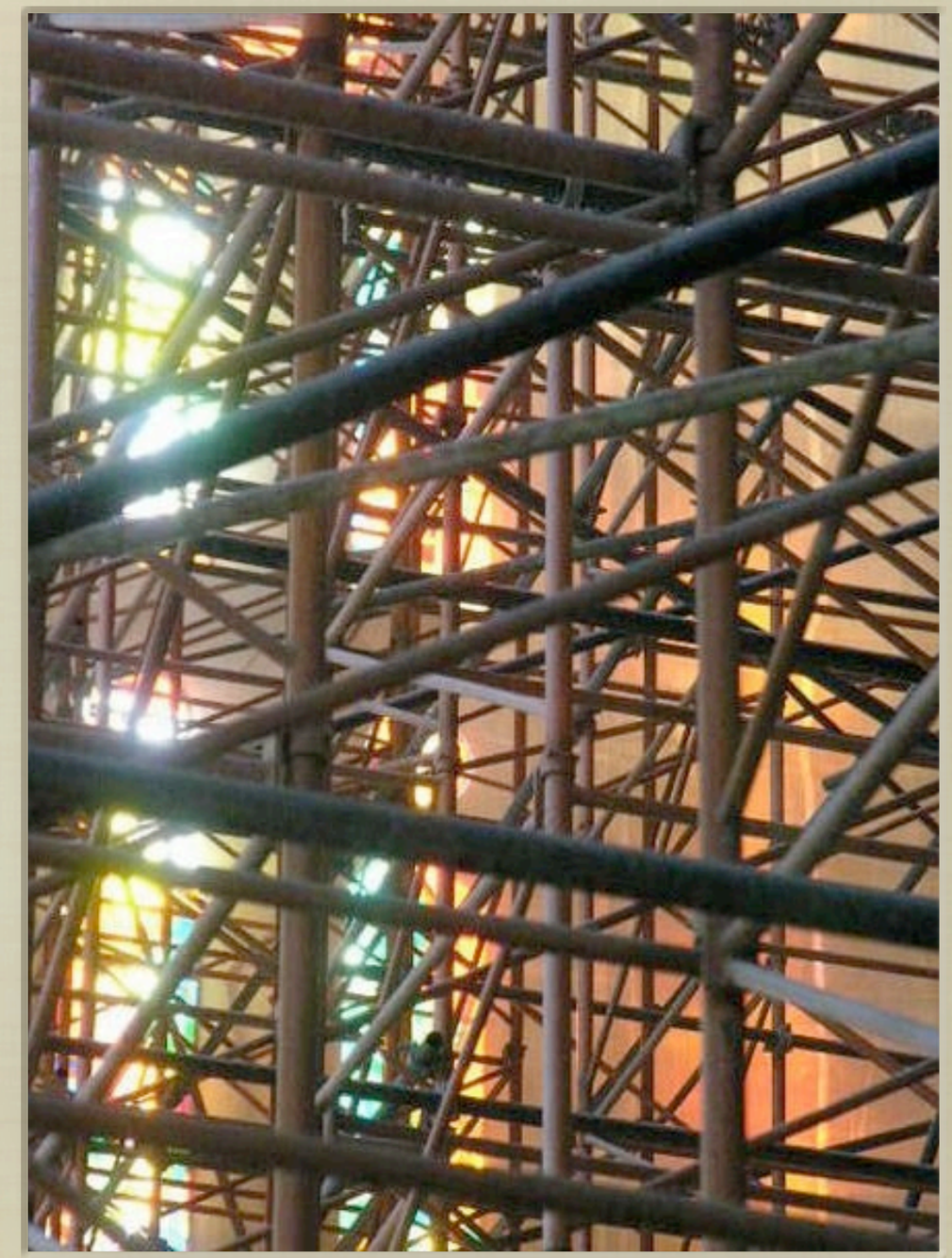
Property Cluster ==> Design Quality



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Property Cluster ==> Design Quality

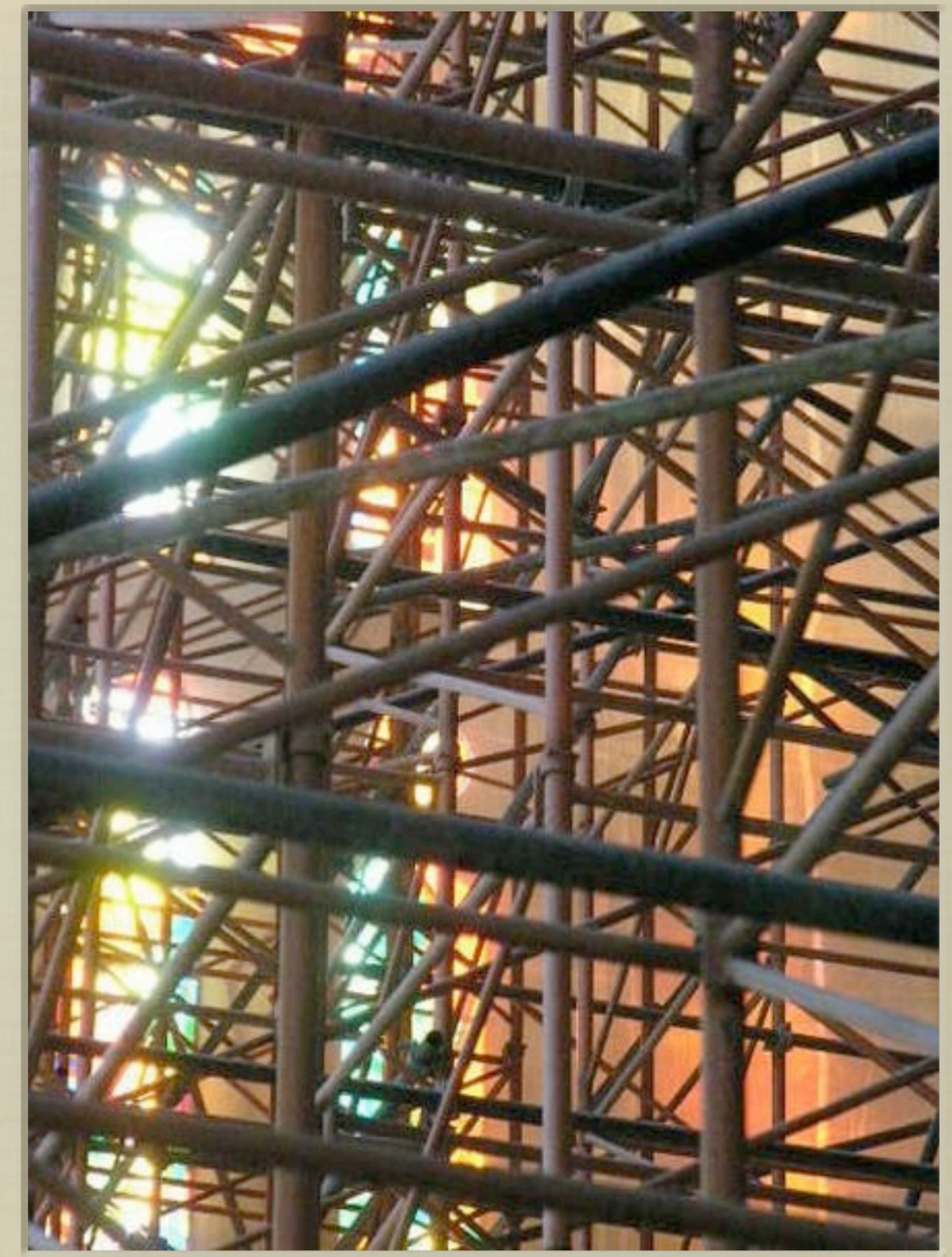
- Each cluster reflects a unique blend of property resonance



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Property Cluster ==> Design Quality

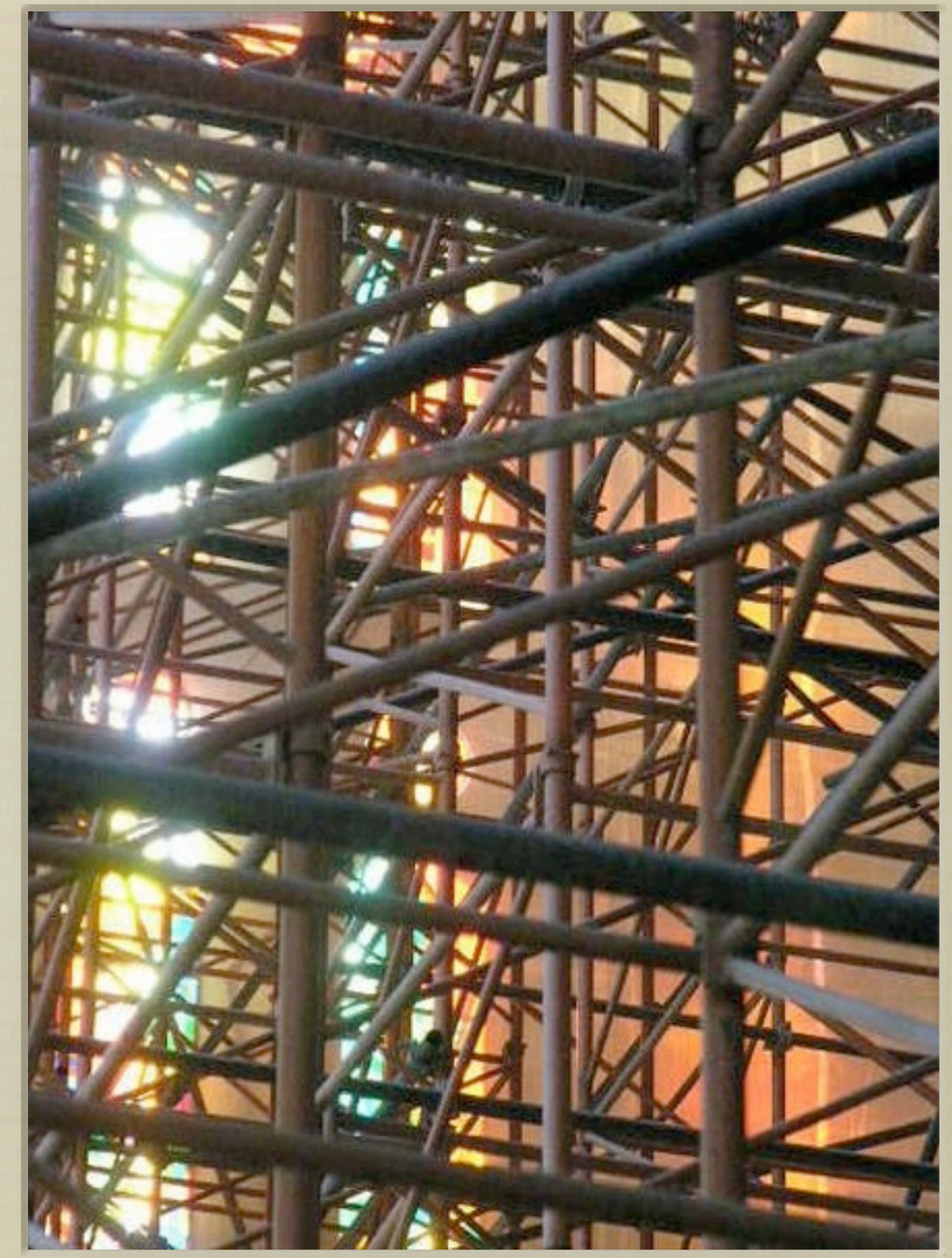
- Each cluster reflects a unique blend of property resonance
- Each cluster explains a particular quality of design



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Property Cluster ==> Design Quality

- Each cluster reflects a unique blend of property resonance
- Each cluster explains a particular quality of design
- Each cluster describes a goal set in design that responds to stakeholder intentions



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Design Quality Naming

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Design Quality Naming

1. Stepwise Refinement

5. Modularization

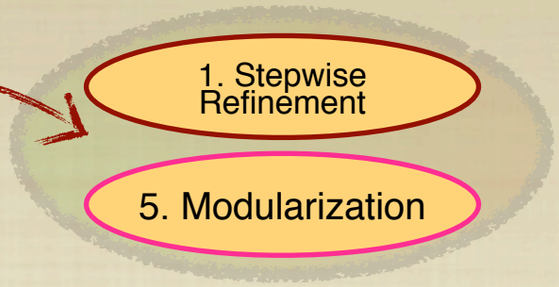
goal-directed decomposition reflects stakeholder perception of relationships among concepts

parts are essential to the distribution and tolerance of complexity

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Design Quality Naming

Divisibility



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Design Quality Naming

Divisibility

1. Stepwise Refinement

5. Modularization

2. Cohesion

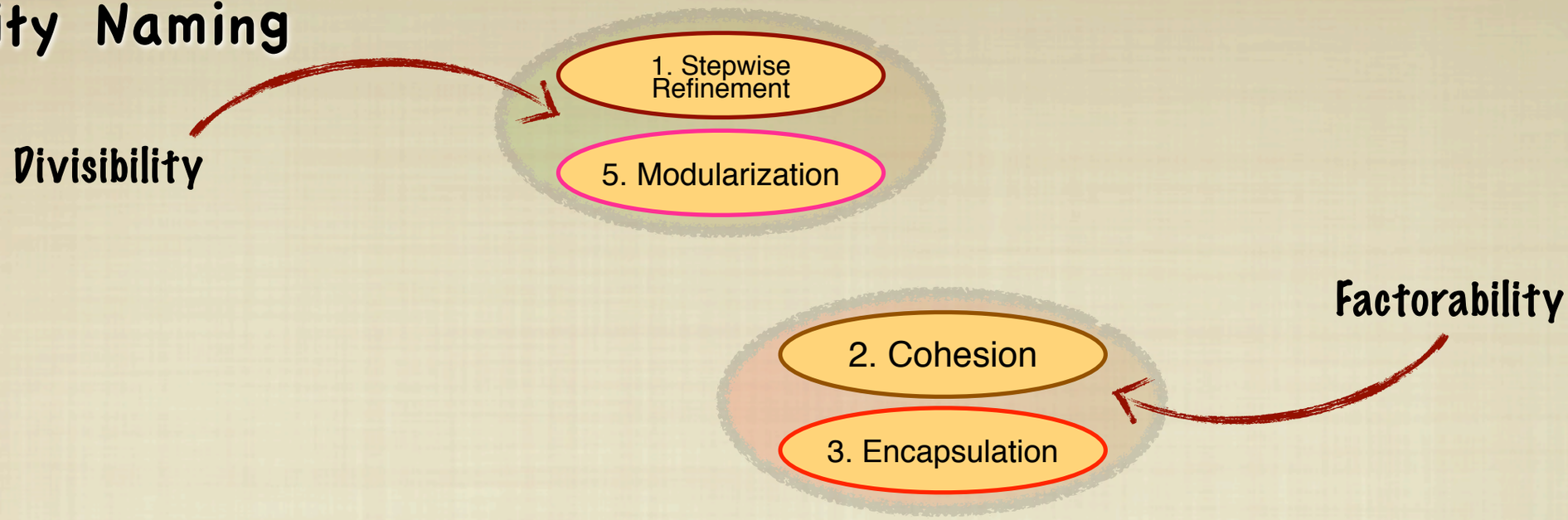
3. Encapsulation

cohesion reflects choice self-sufficiency: well-formed with cogency

encapsulation bounds but also interfaces the choice to the surrounding collection

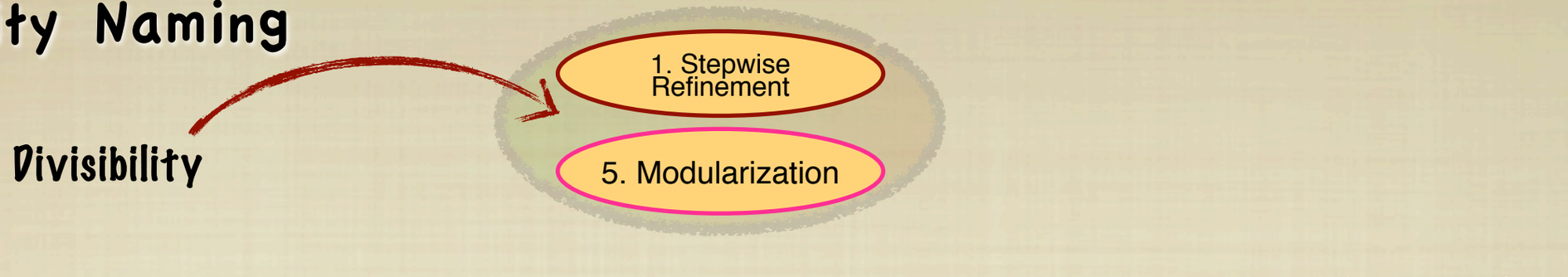
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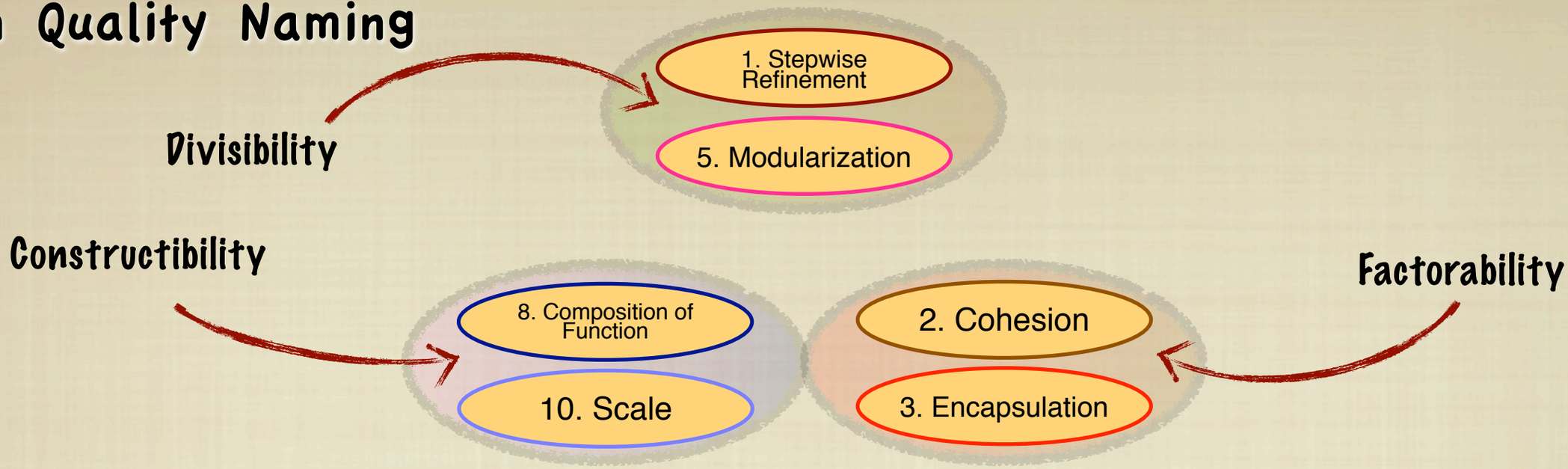


composable choices enable growth in capacity or complexity; new choices composed from existing ones

scale reflects a useful granularity of attention or focus

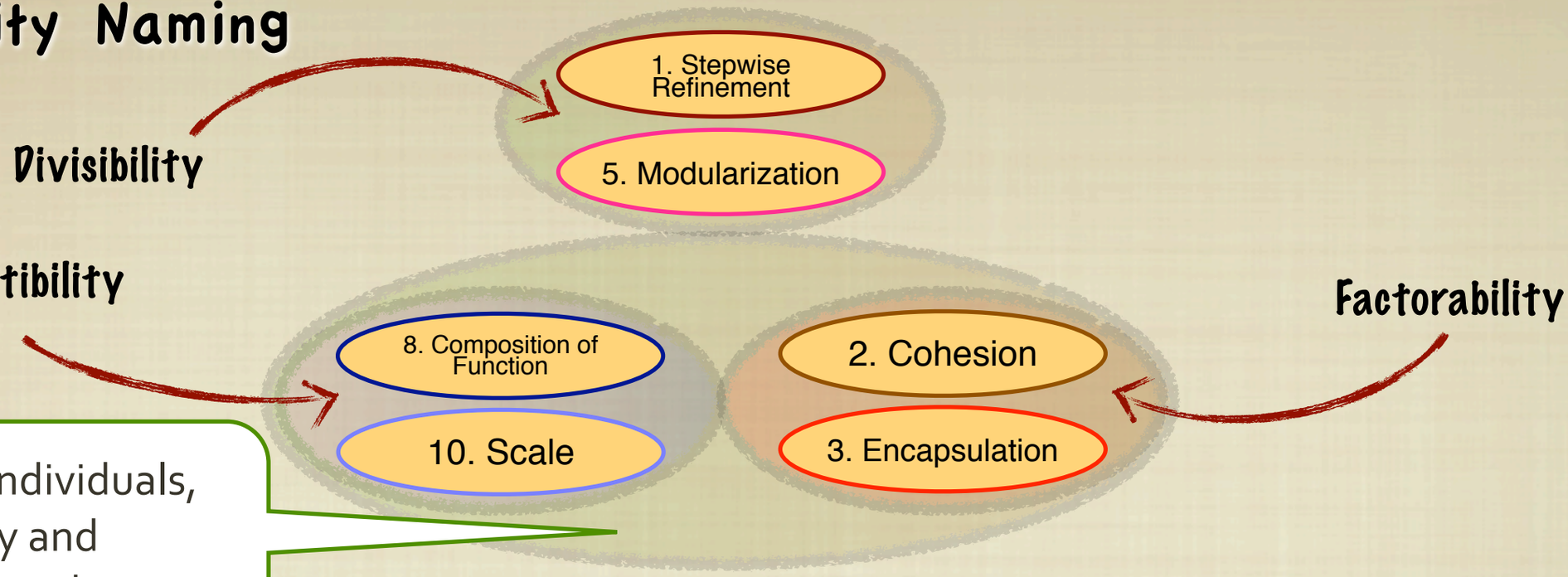
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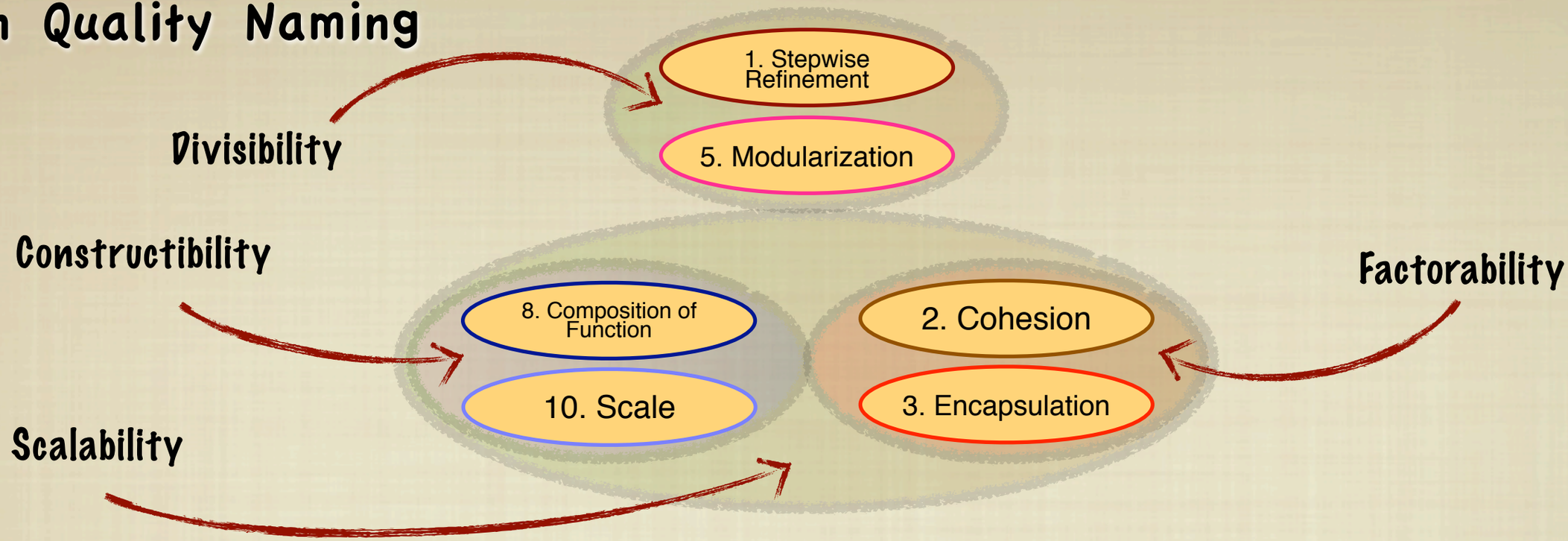


soundness of individuals, internal stability and structural independence

opportunity of combining to build larger/more capable arrangements

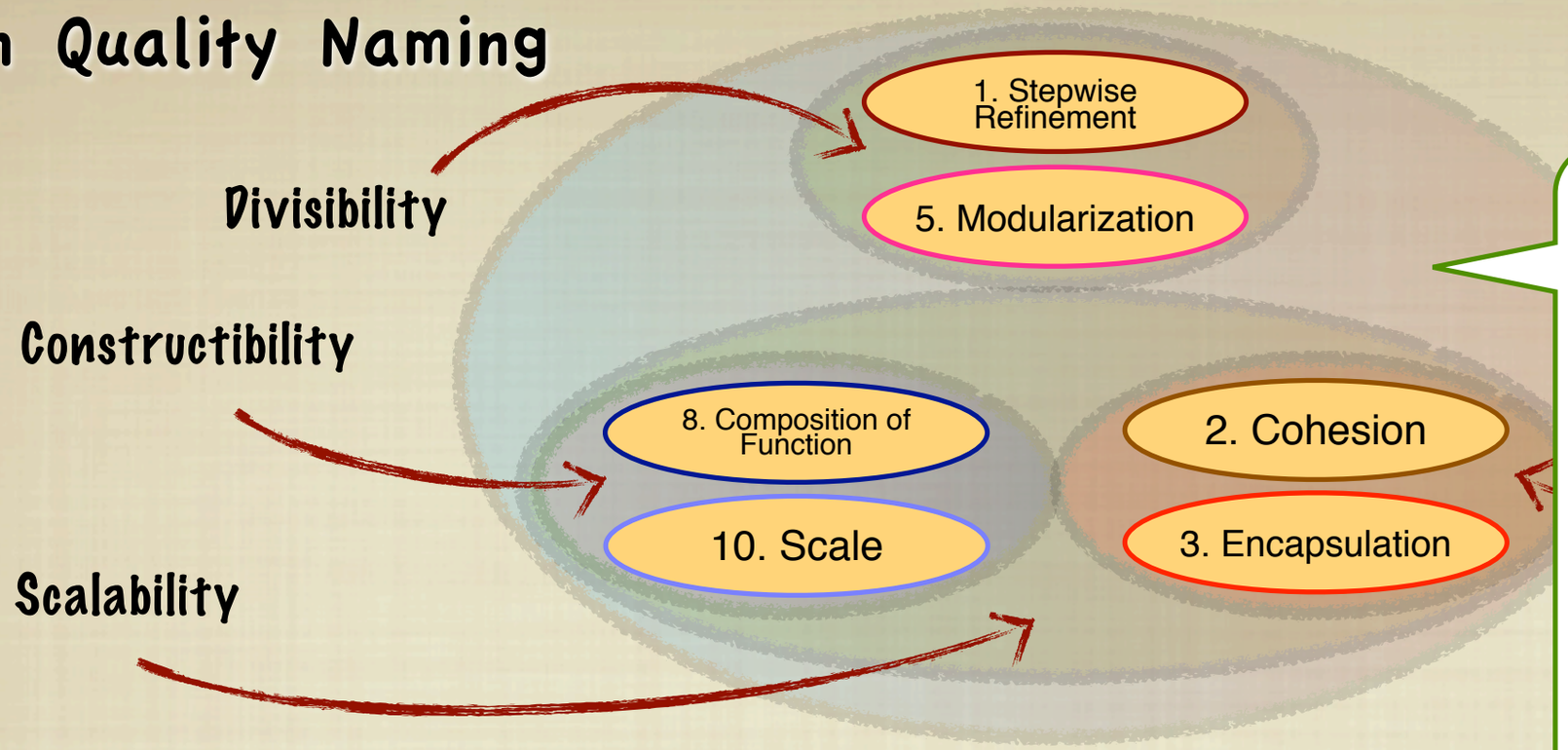
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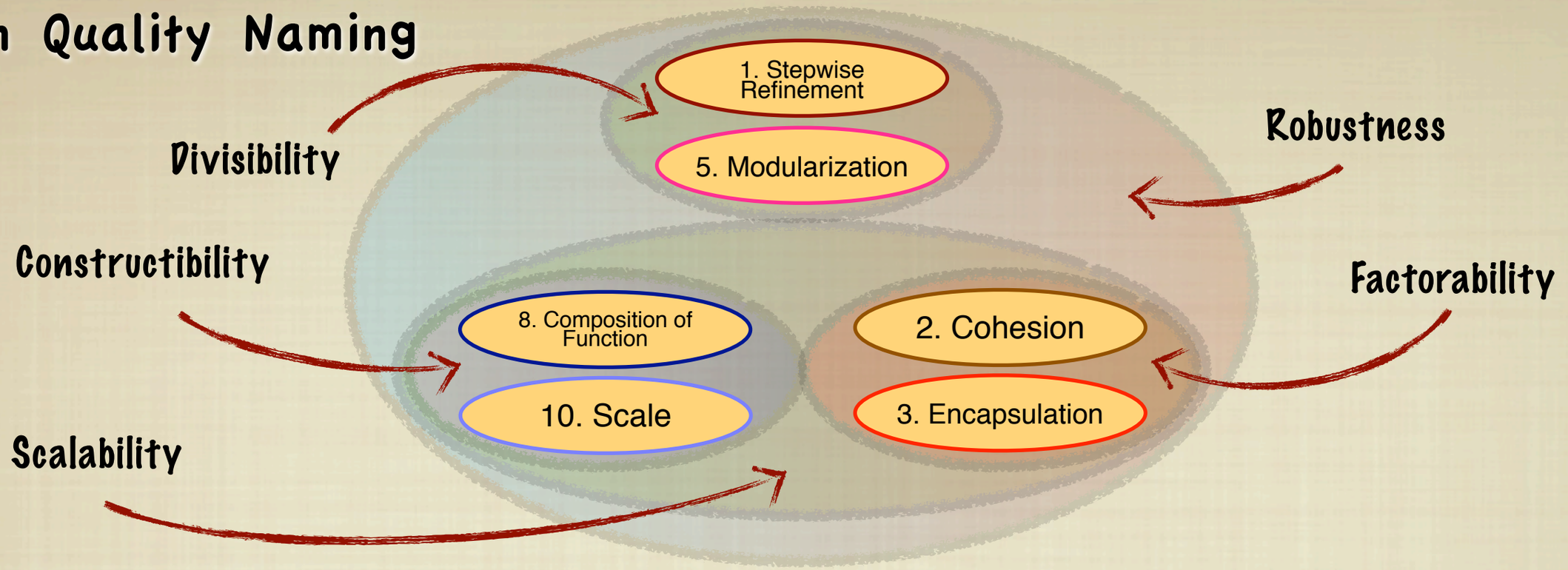


divisible, sound, static structure: building blocks; iteratively decomposed and assembled, separating and insulating concerns

scalability enabling composition, fusing independent self-sufficiency to span the breadth and width of stakeholder intentions

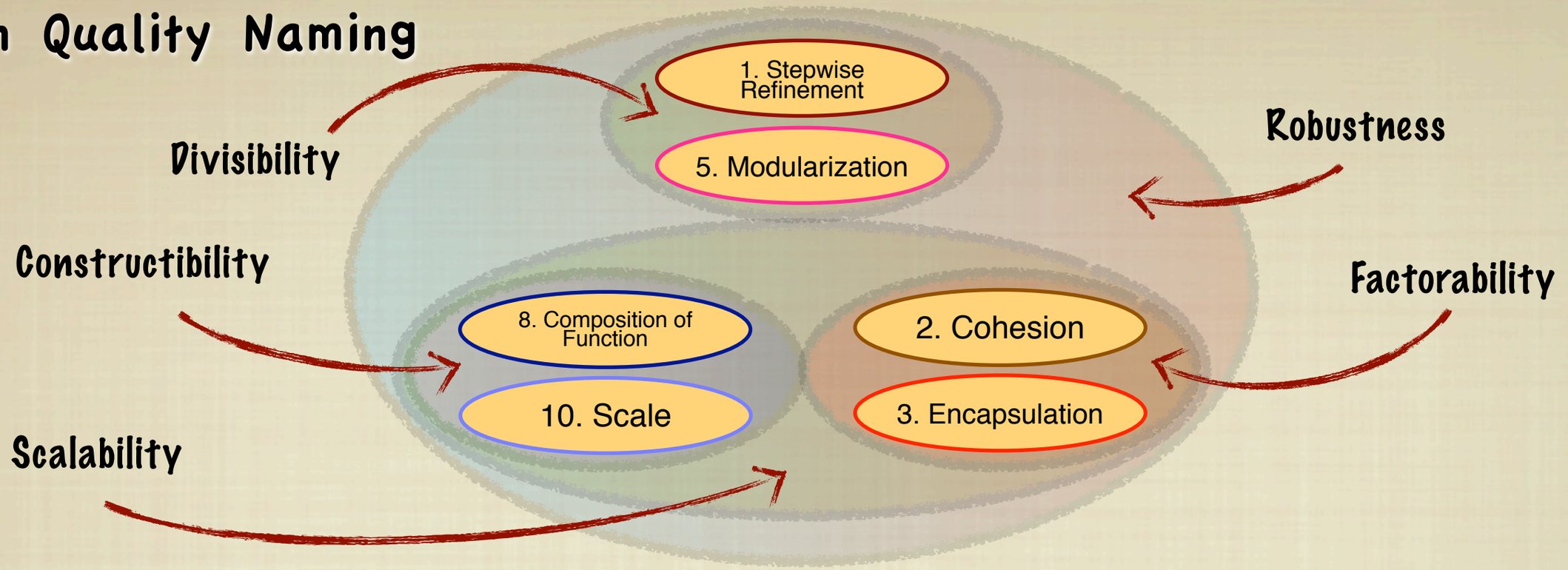
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6. Correctness

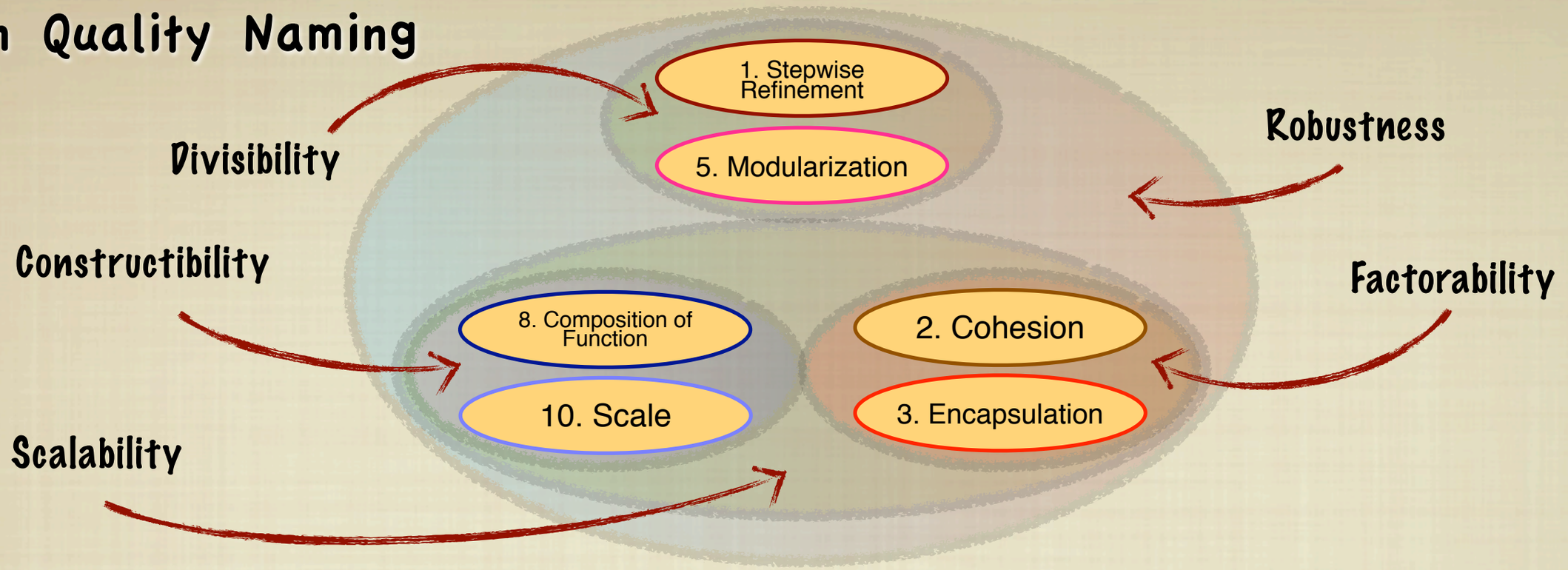
11. User Friendliness

choice alignment with intentions (dynamically)

a perception of "what is natural," "seeing" what you expect reinforces reliance and trust

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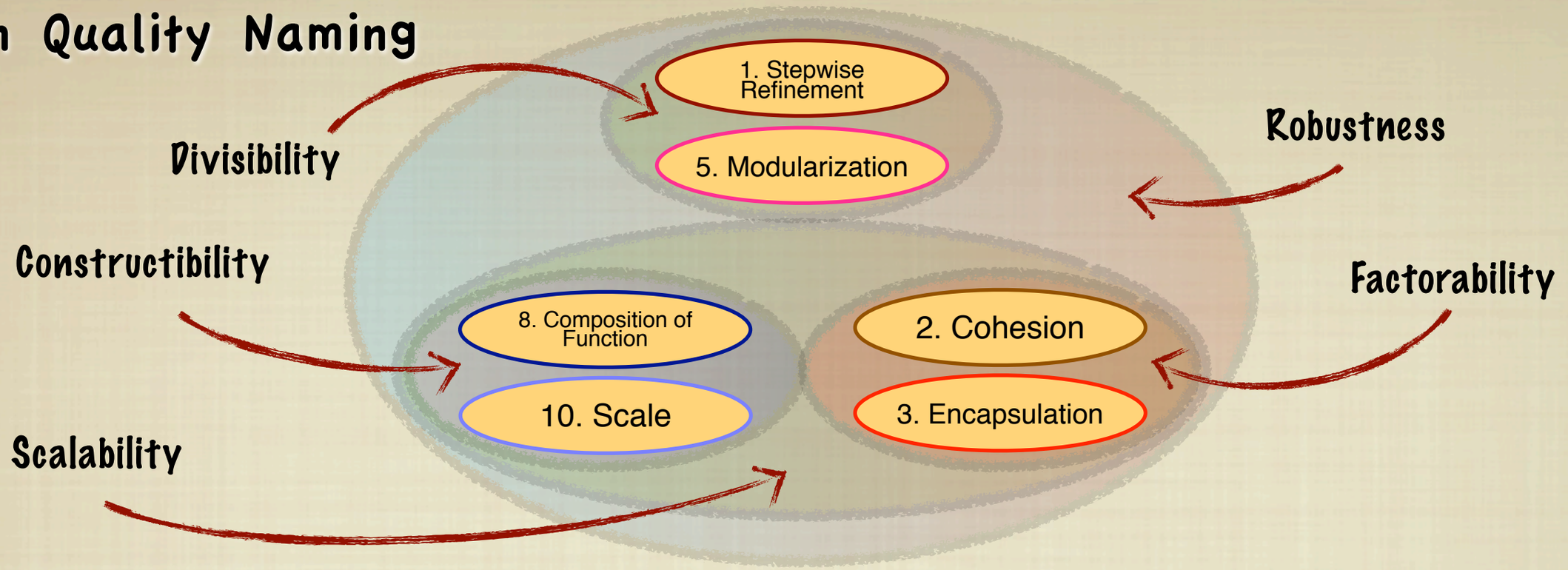
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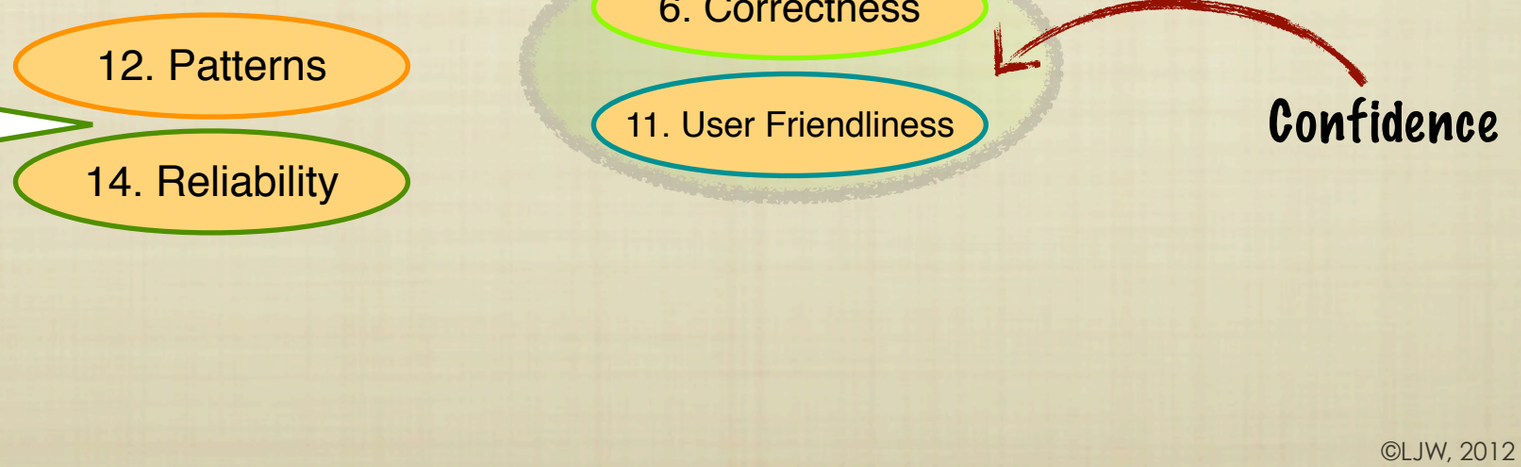
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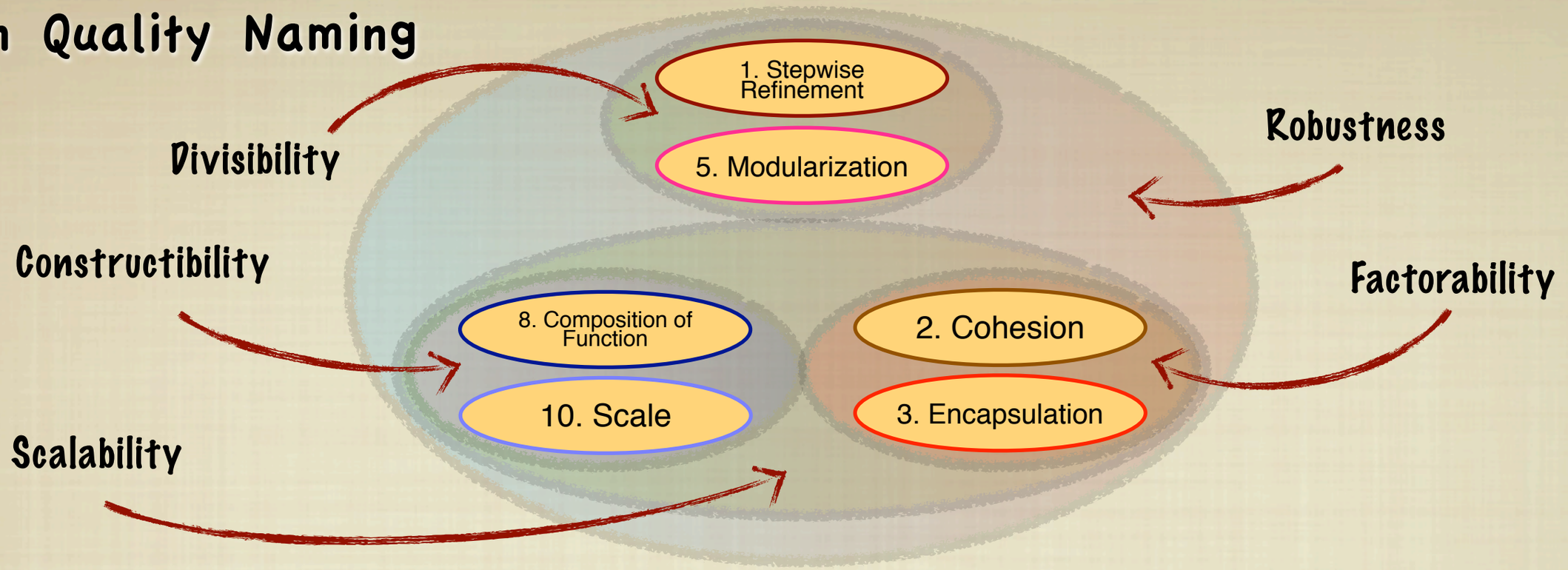
proven formulae or techniques enable repeatable success

consistently safe practice continues success with compatible challenges



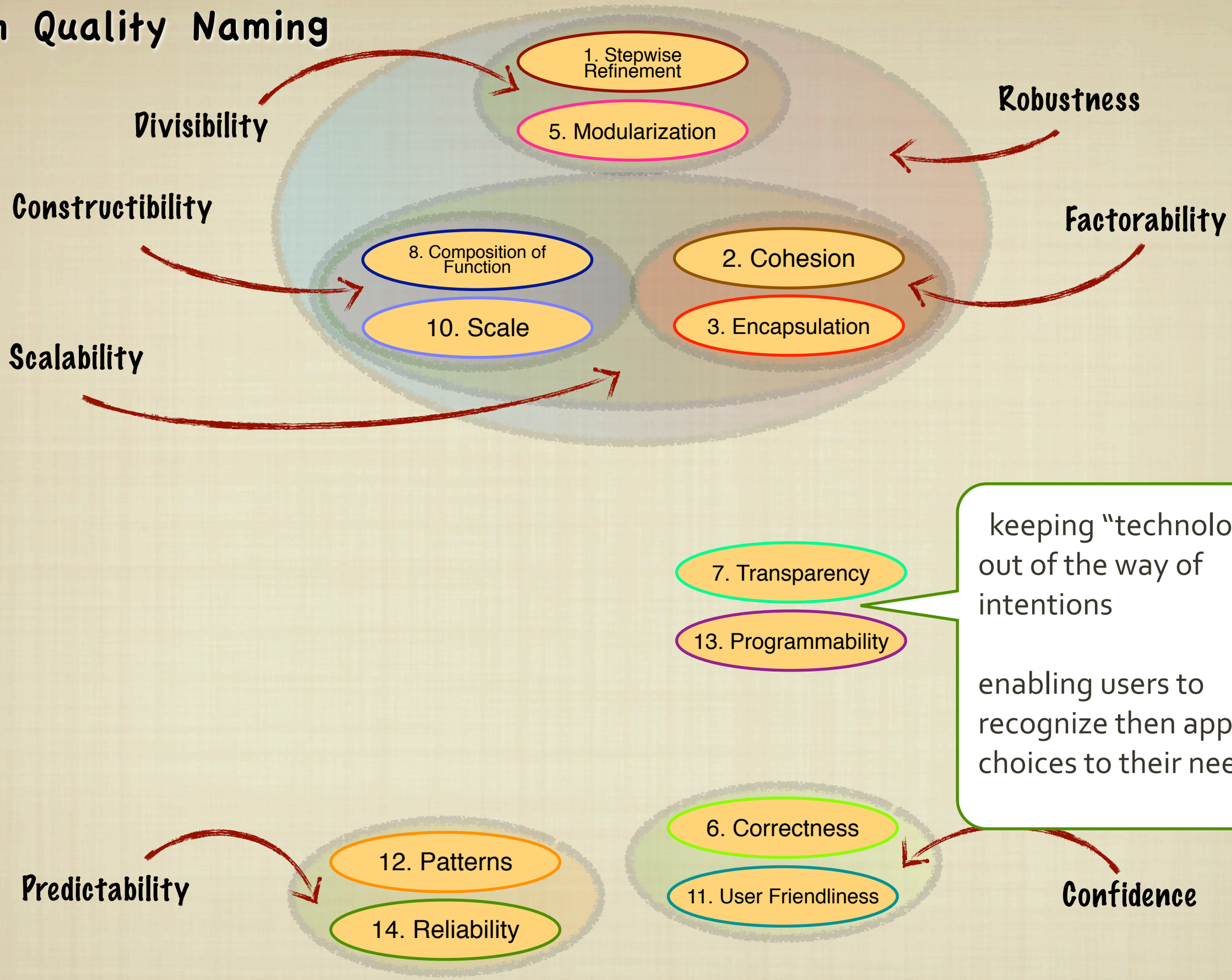
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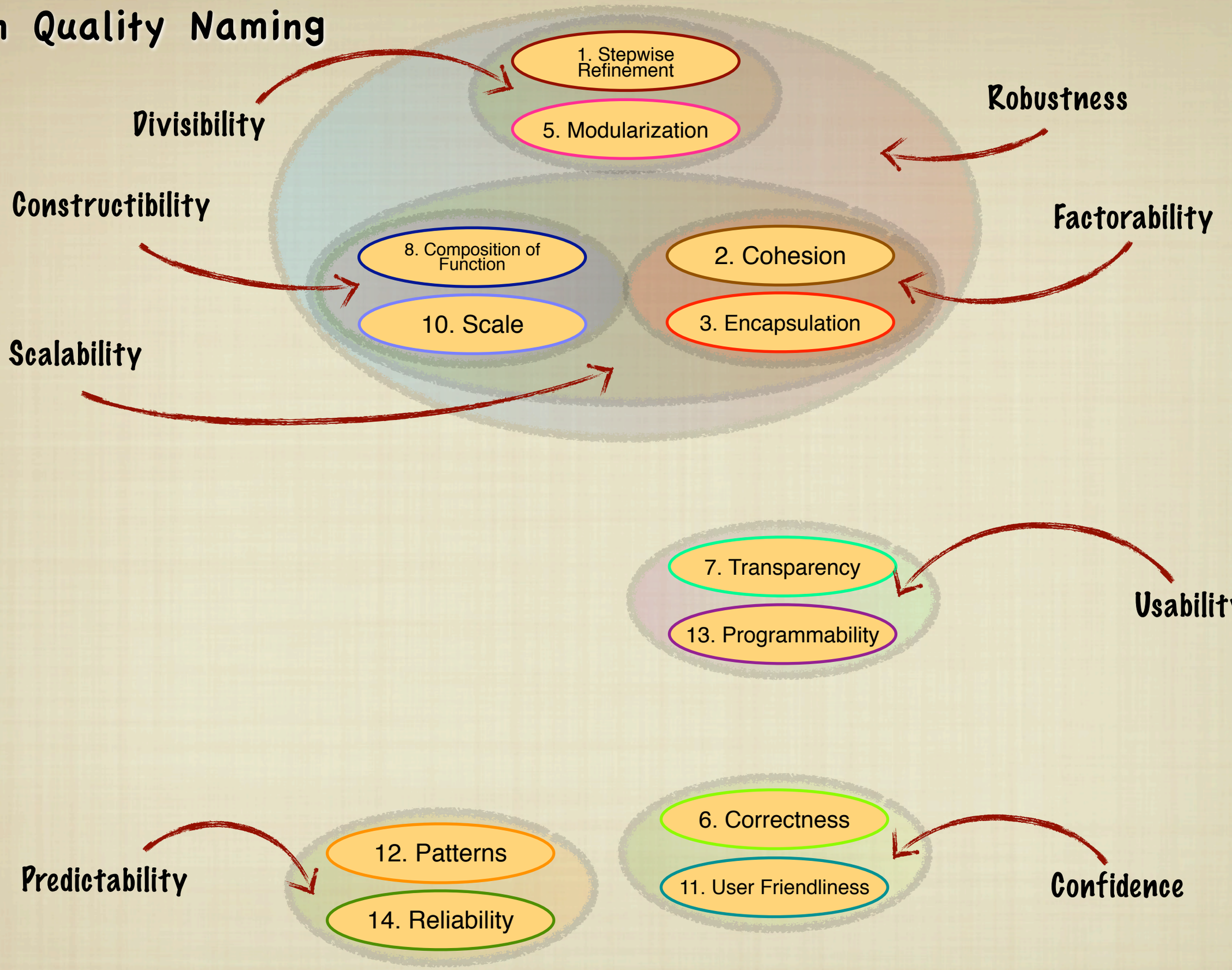
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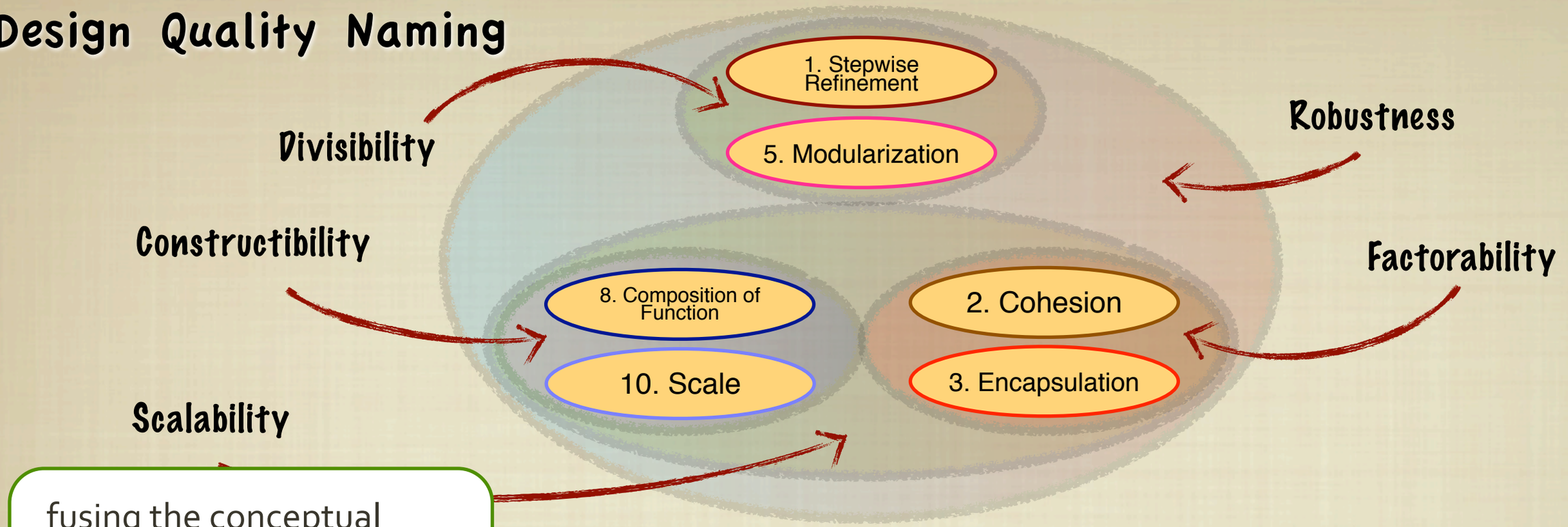
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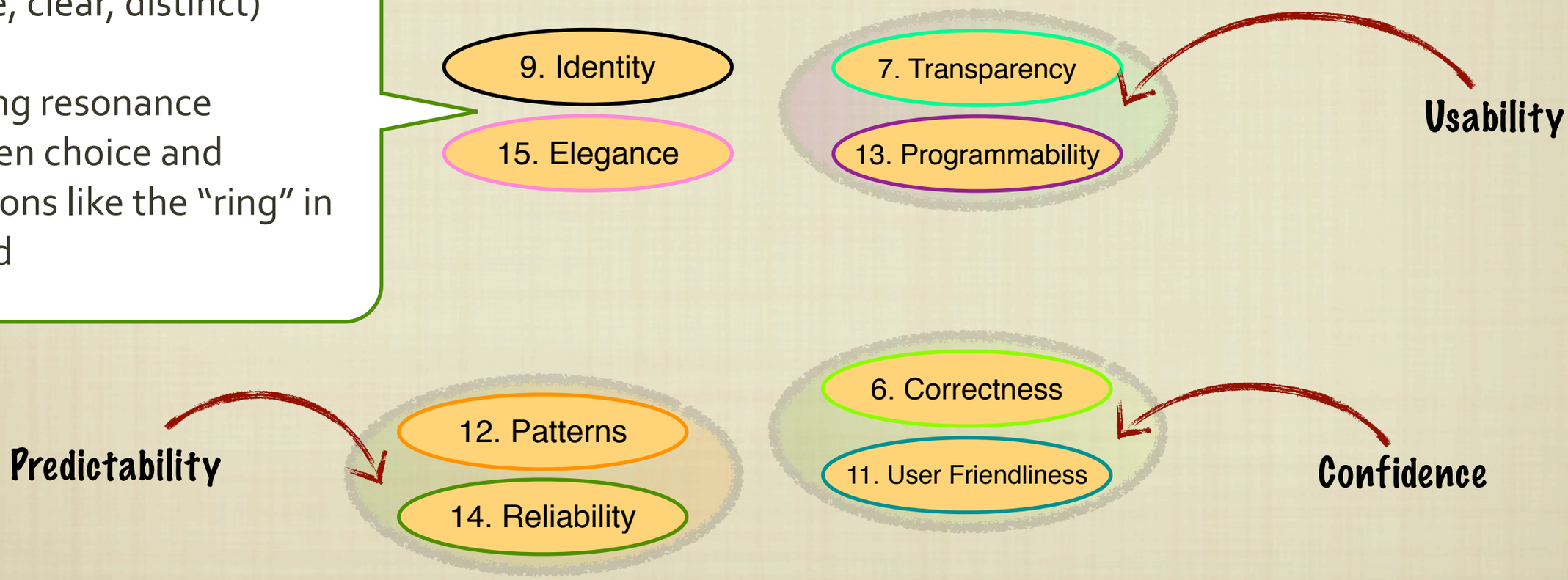
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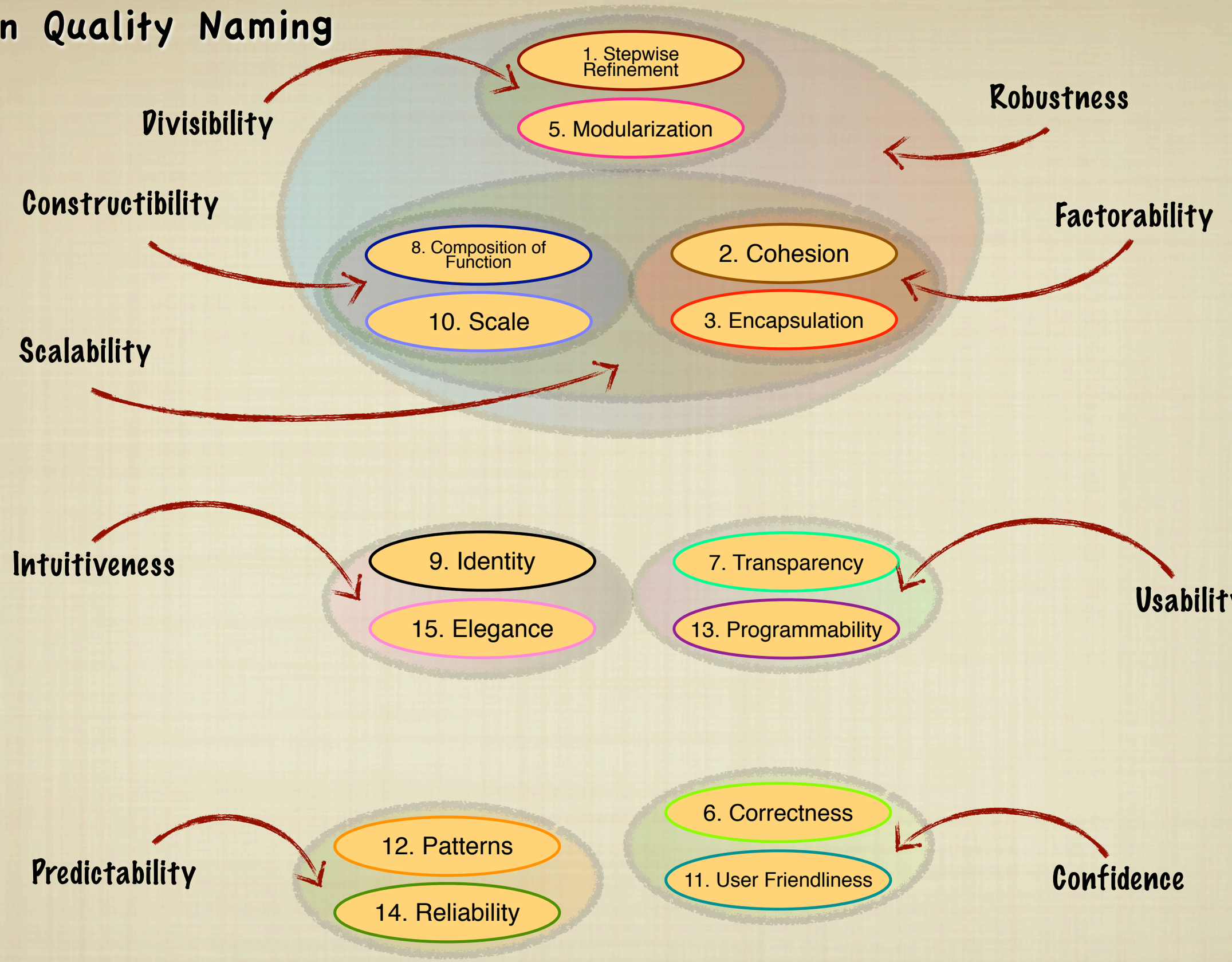
fusing the conceptual with the linguistic (concise, precise, clear, distinct)

realizing resonance between choice and intentions like the "ring" in a chord



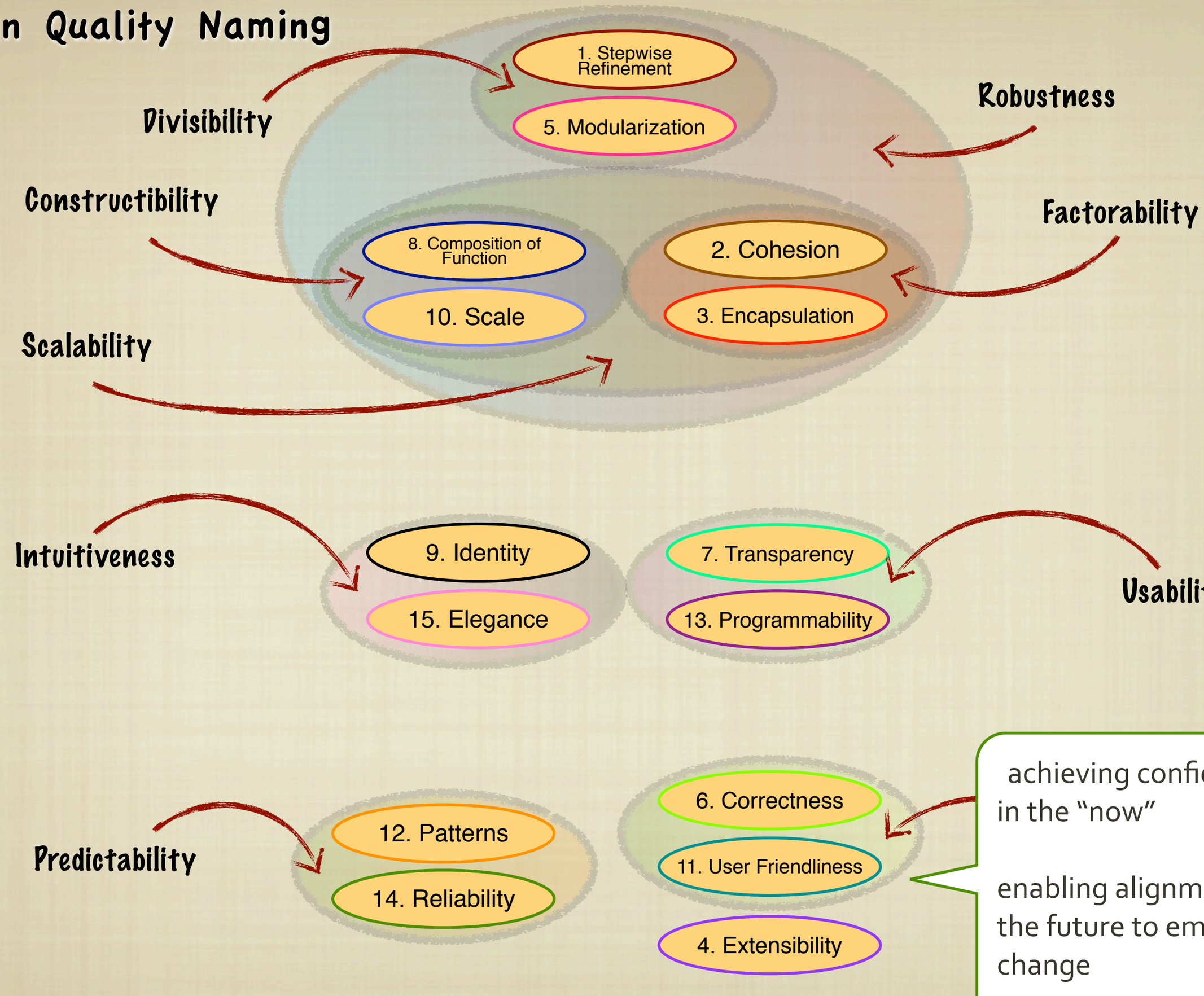
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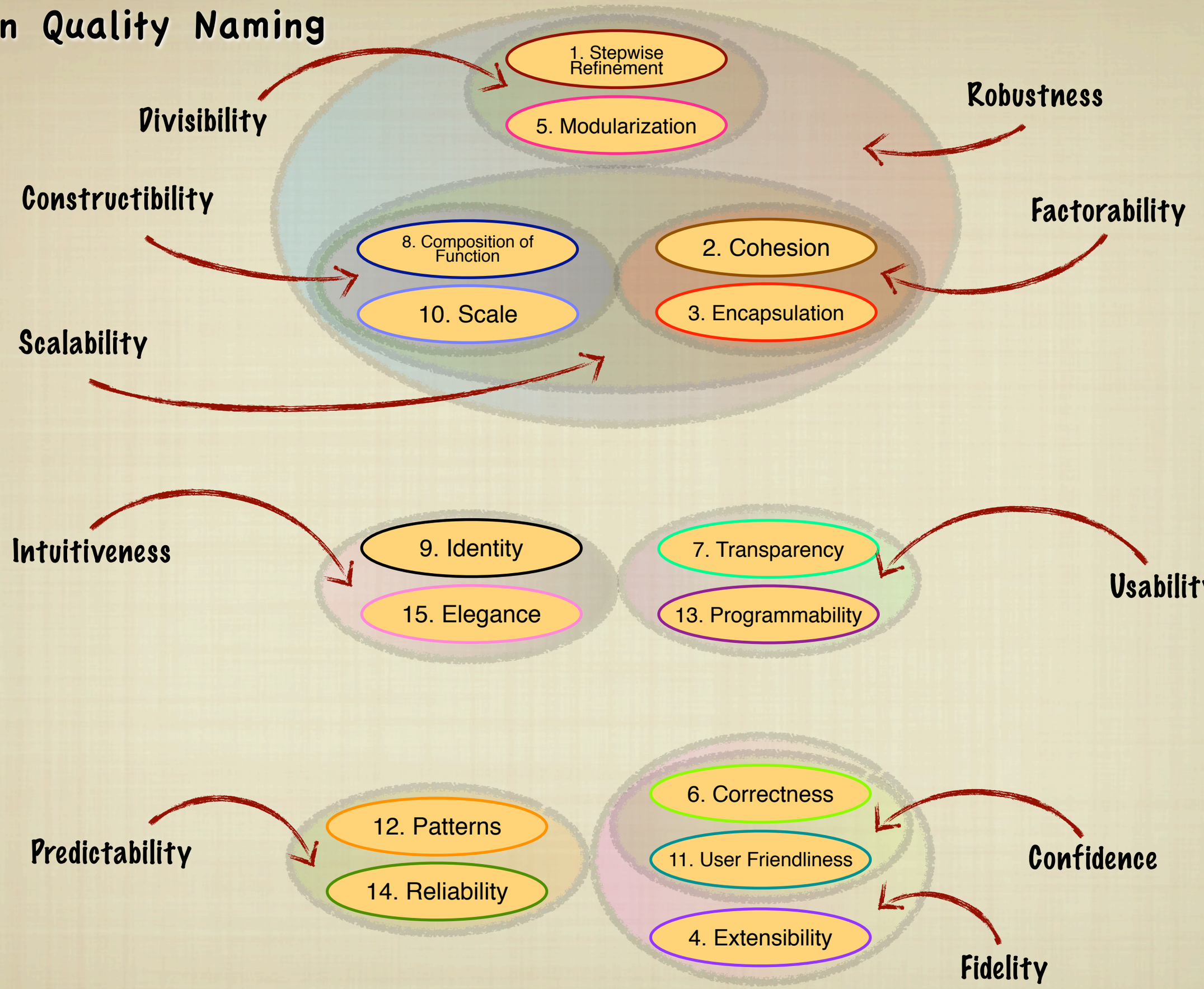
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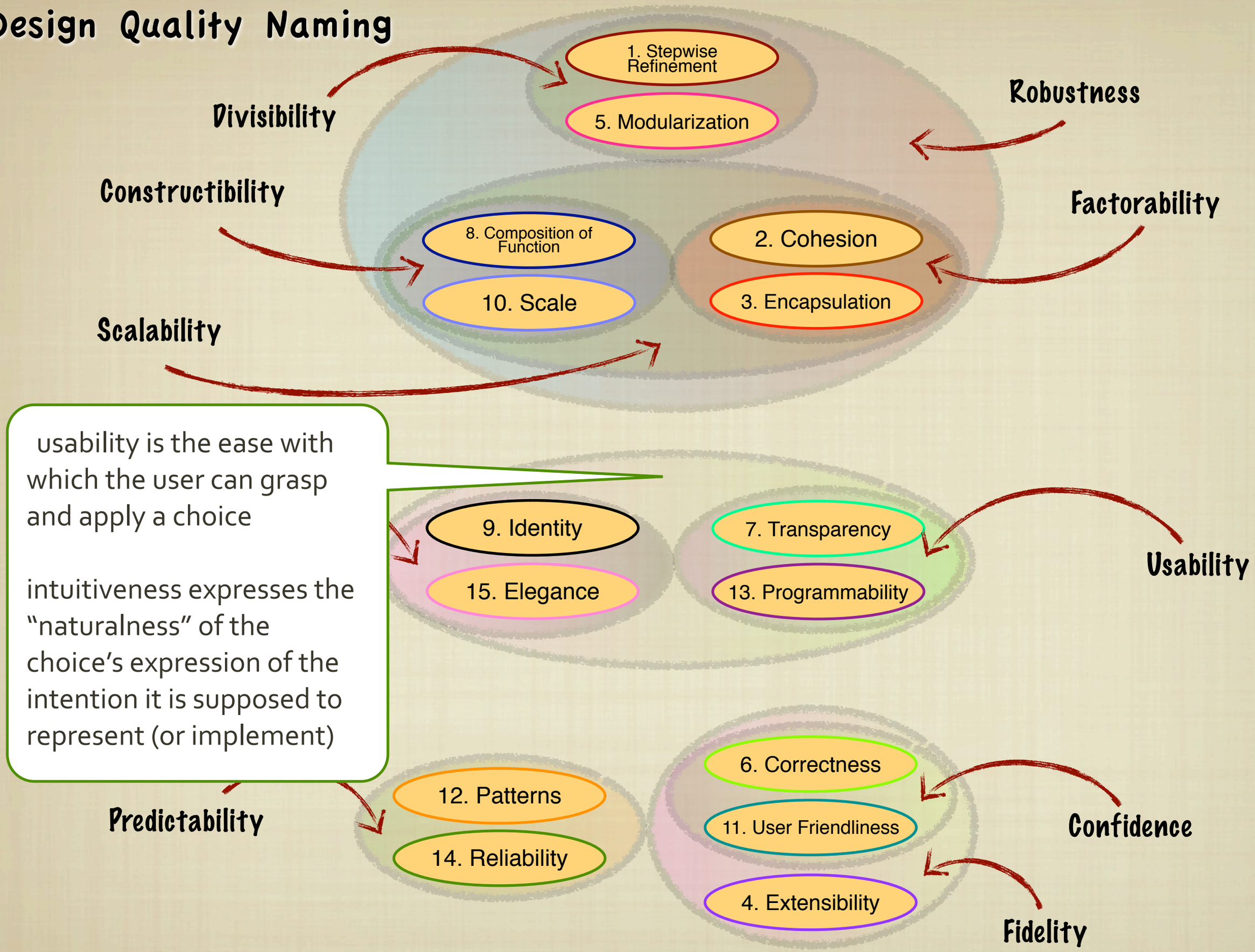
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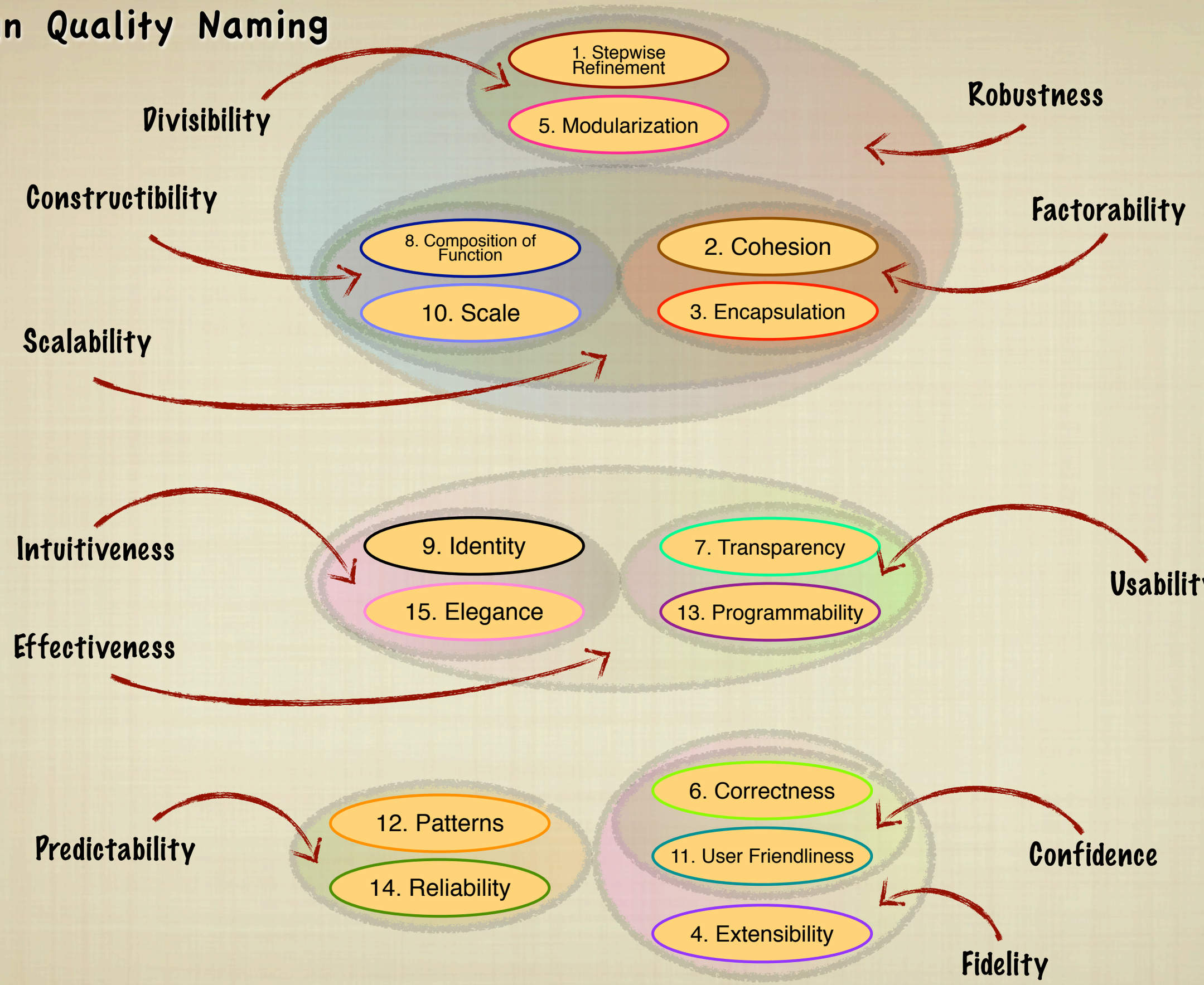
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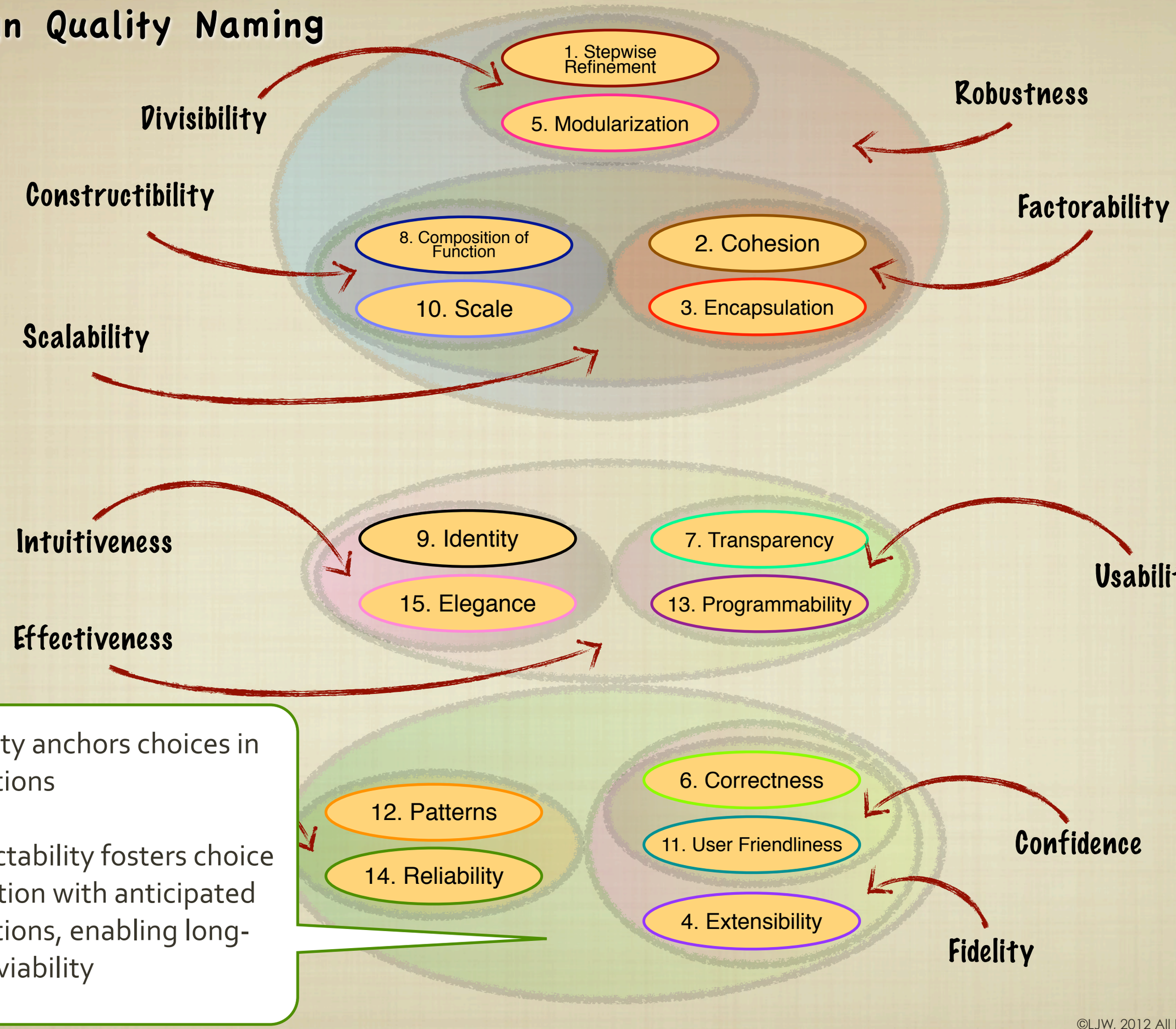
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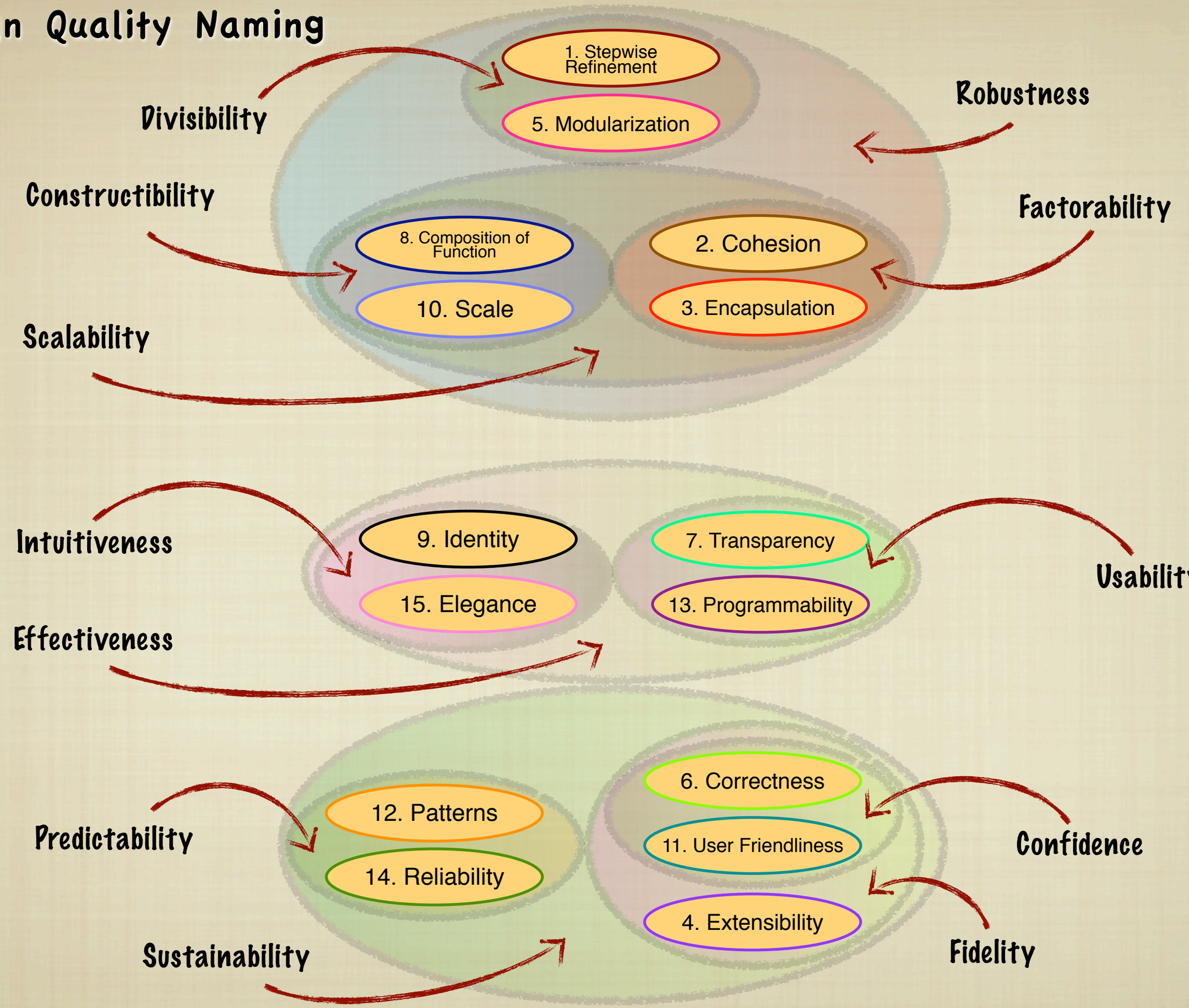


fidelity anchors choices in intentions

predictability fosters choice evolution with anticipated intentions, enabling long-term viability

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Design Quality Naming

Divisibility

1. Stepwise Refinement

5. Modularization

Robustness

Constructibility

8. Composition of Function

10. Scale

2. Cohesion

3. Encapsulation

Factorability

Scalability

Intuitiveness

9. Identity

15. Elegance

7. Transparency

13. Programmability

Effectiveness

Predictability

12. Patterns

14. Reliability

6. Correctness

11. User Friendliness

4. Extensibility

Sustainability

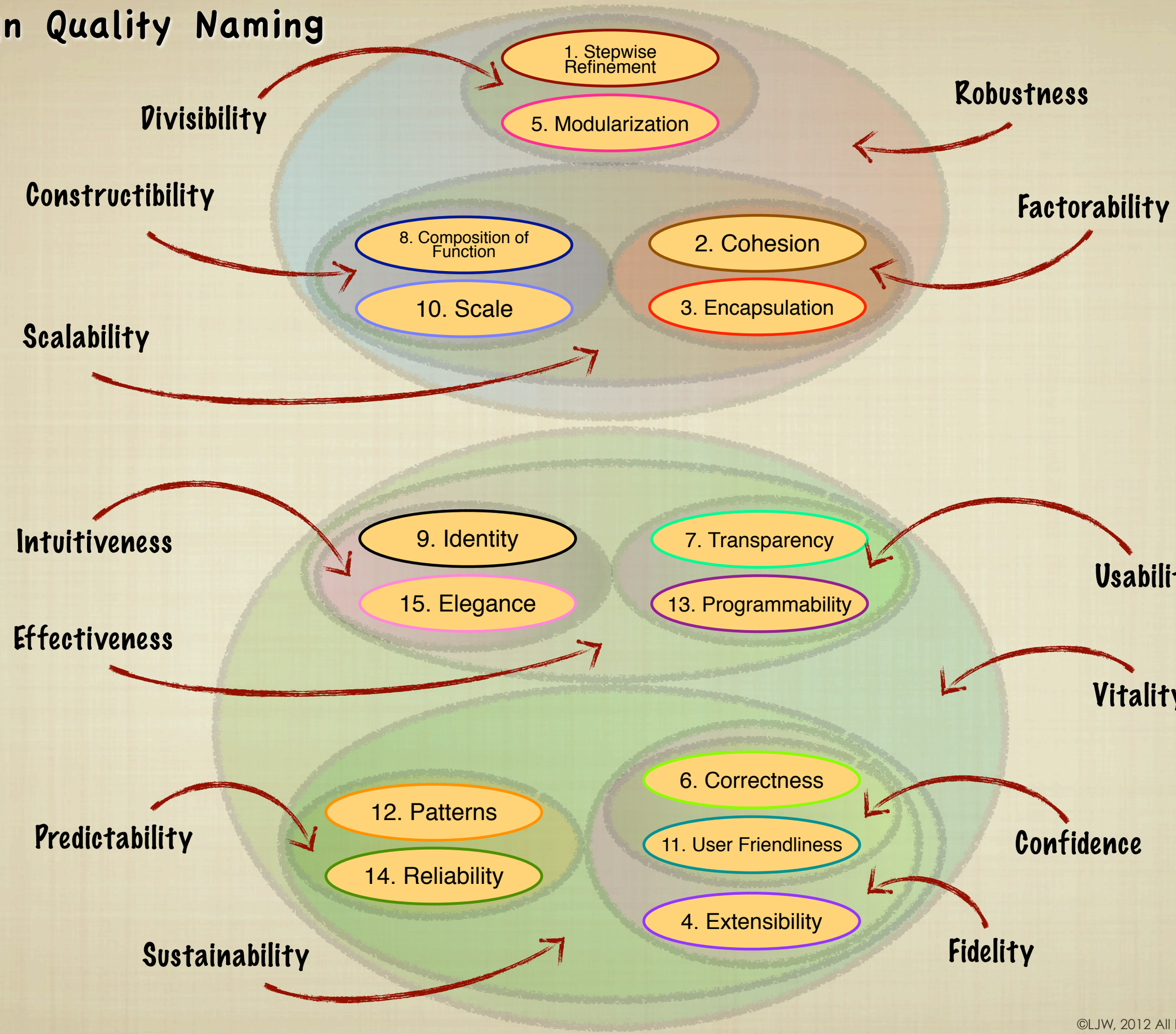
Fidelity

effectively representing intentions: choices that are understandable and applicable

choices aligned in the current reality; poised to respond to change; to grow predictably and evolve

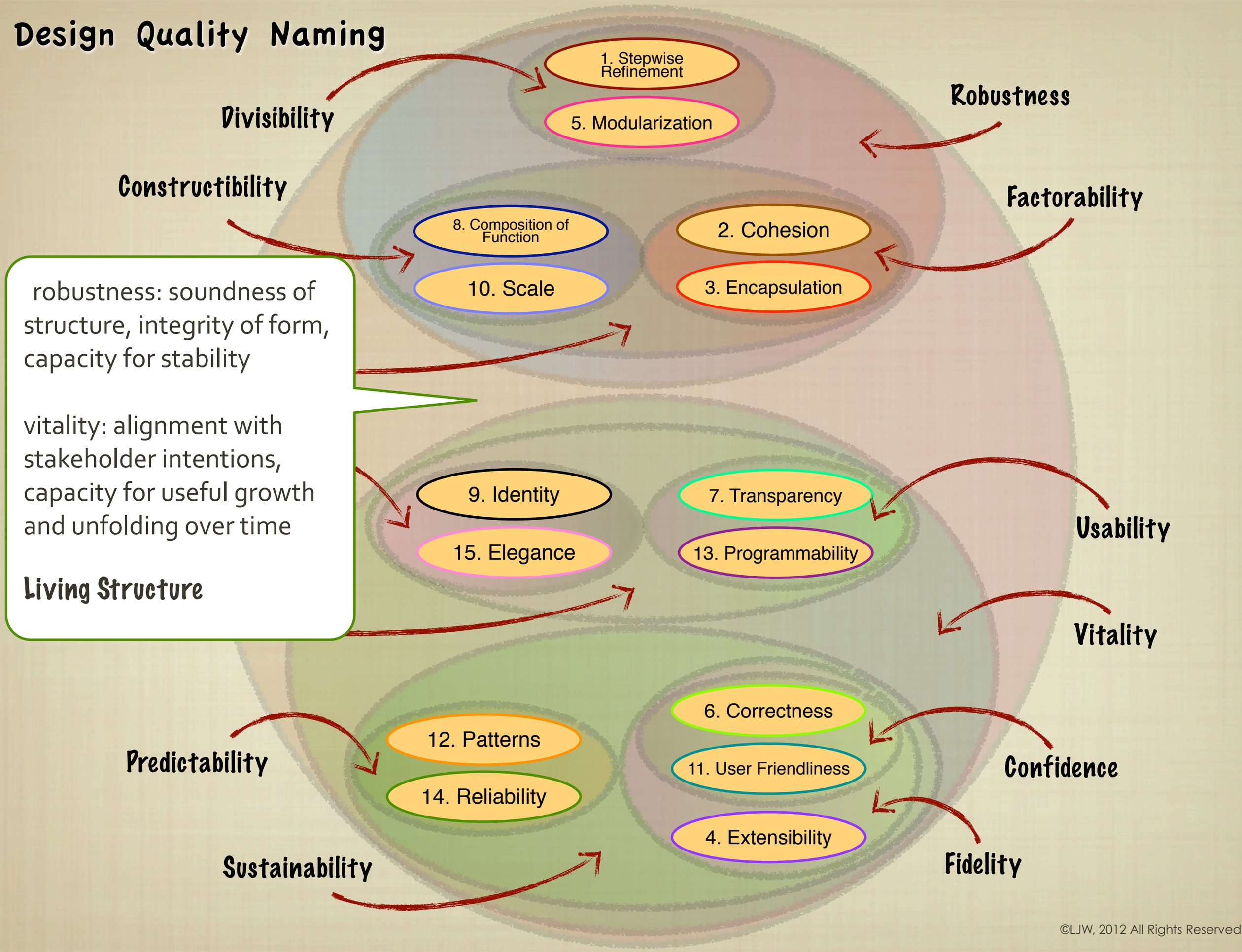
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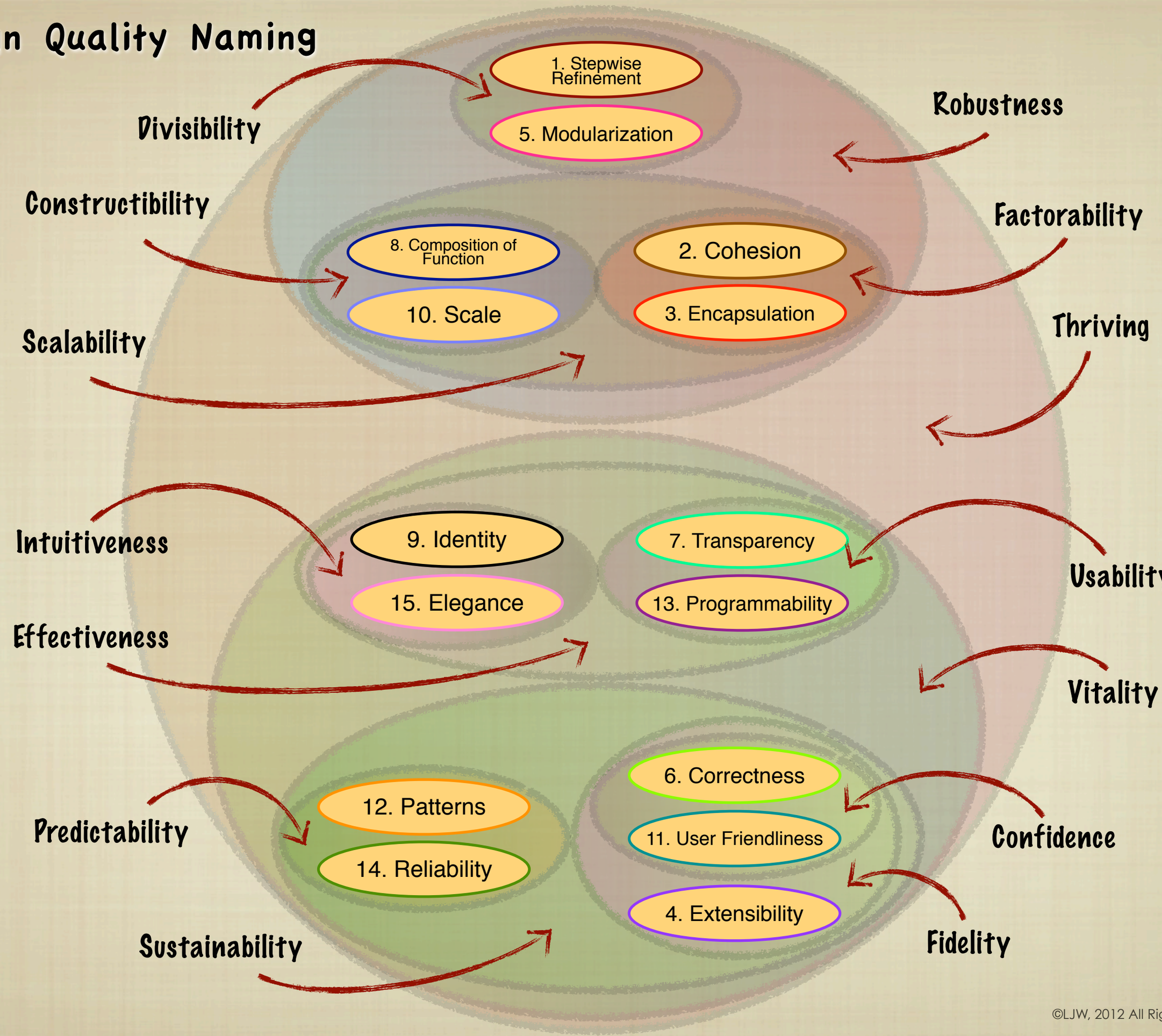
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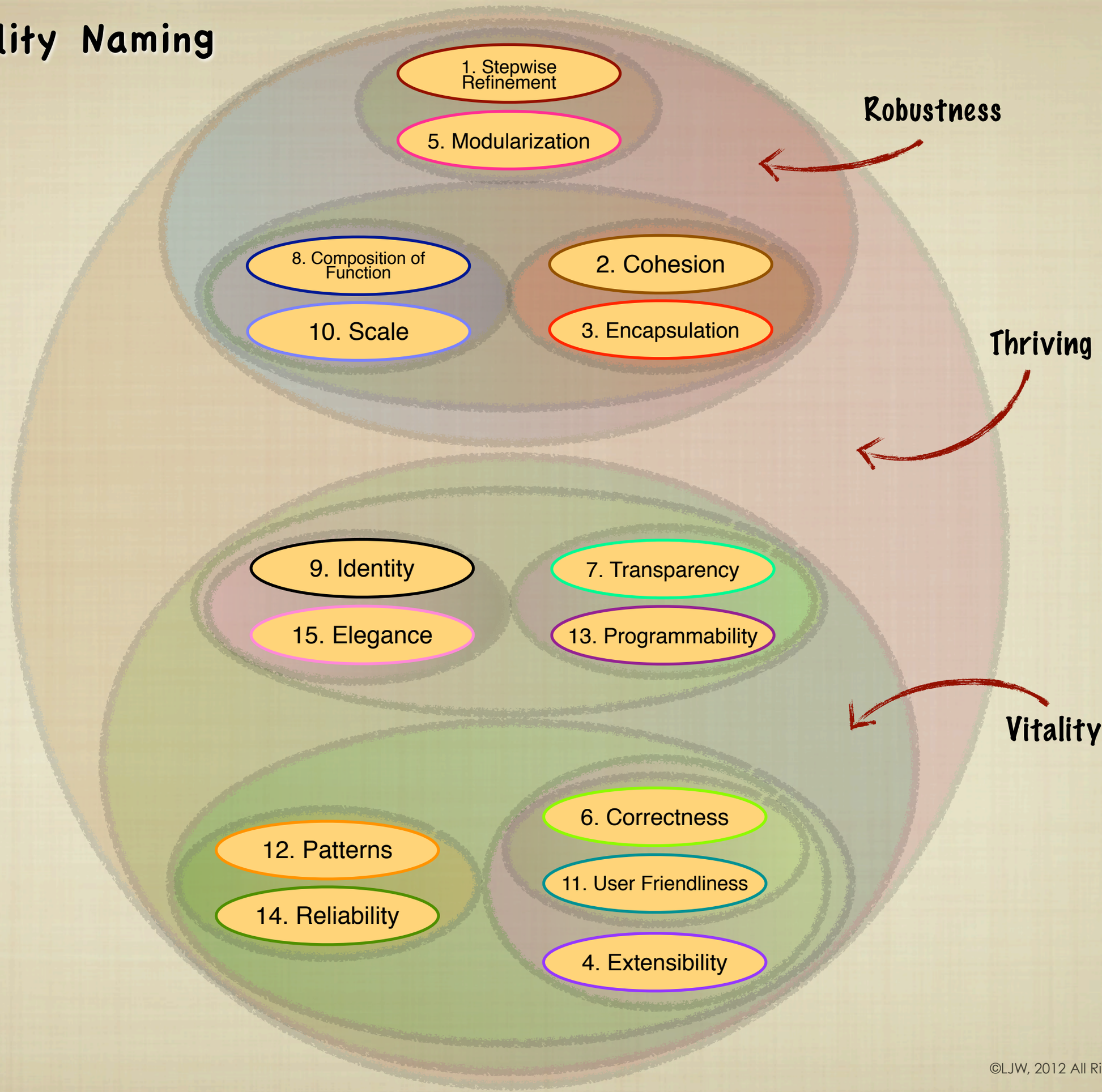
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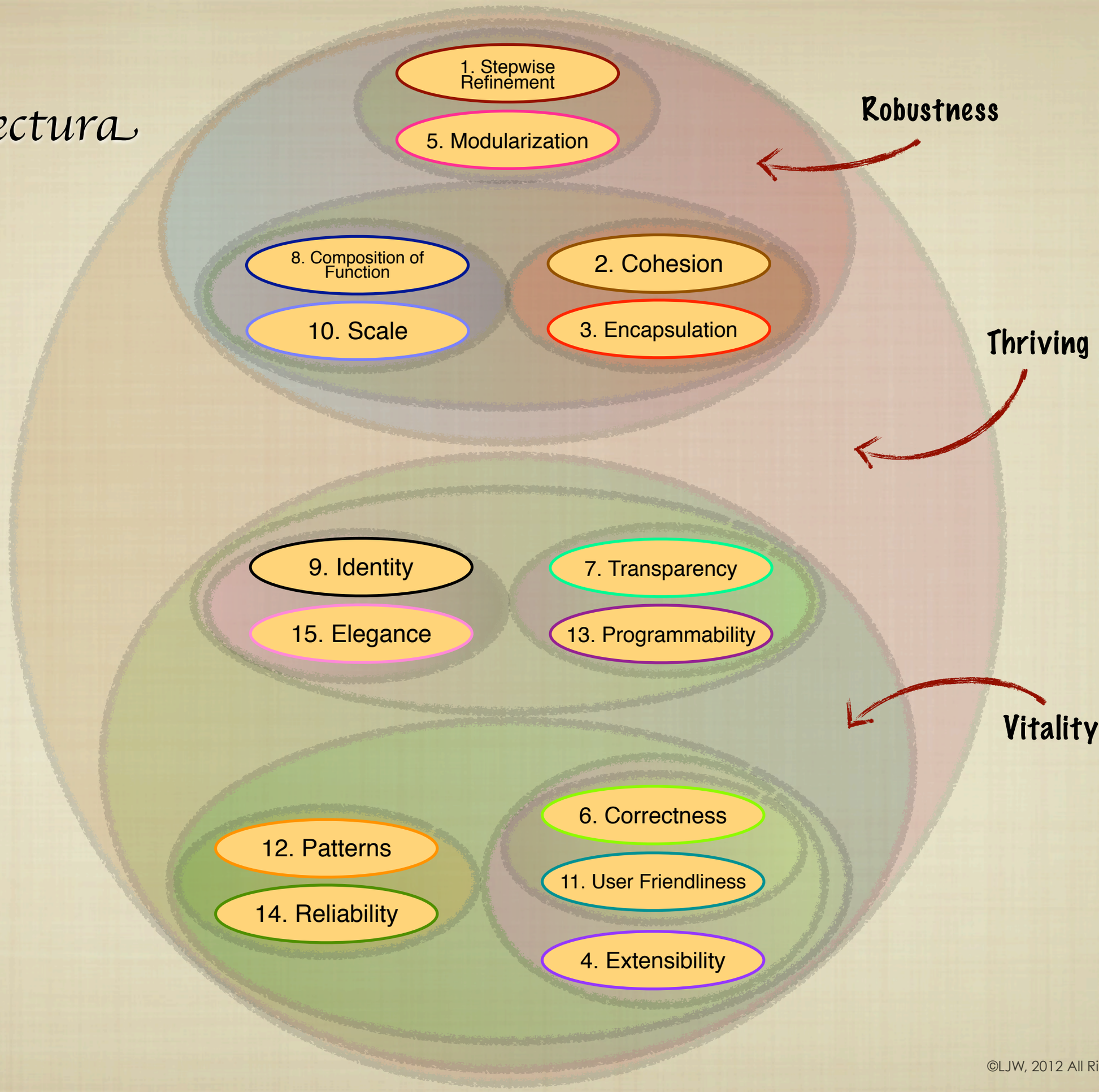


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Vitruvius

De architectura

78 BC

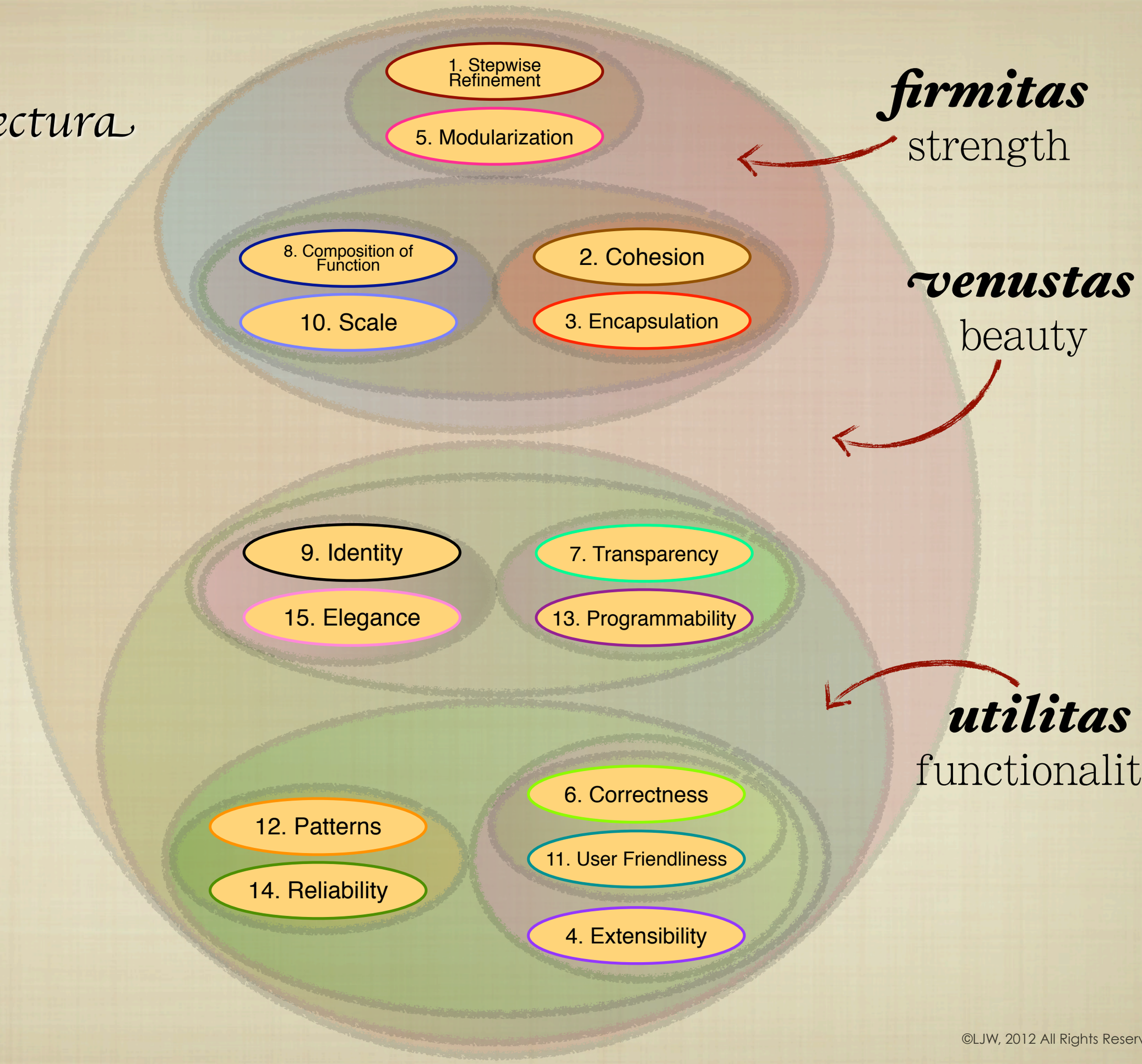


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Vitruvius

De architectura

78 BC



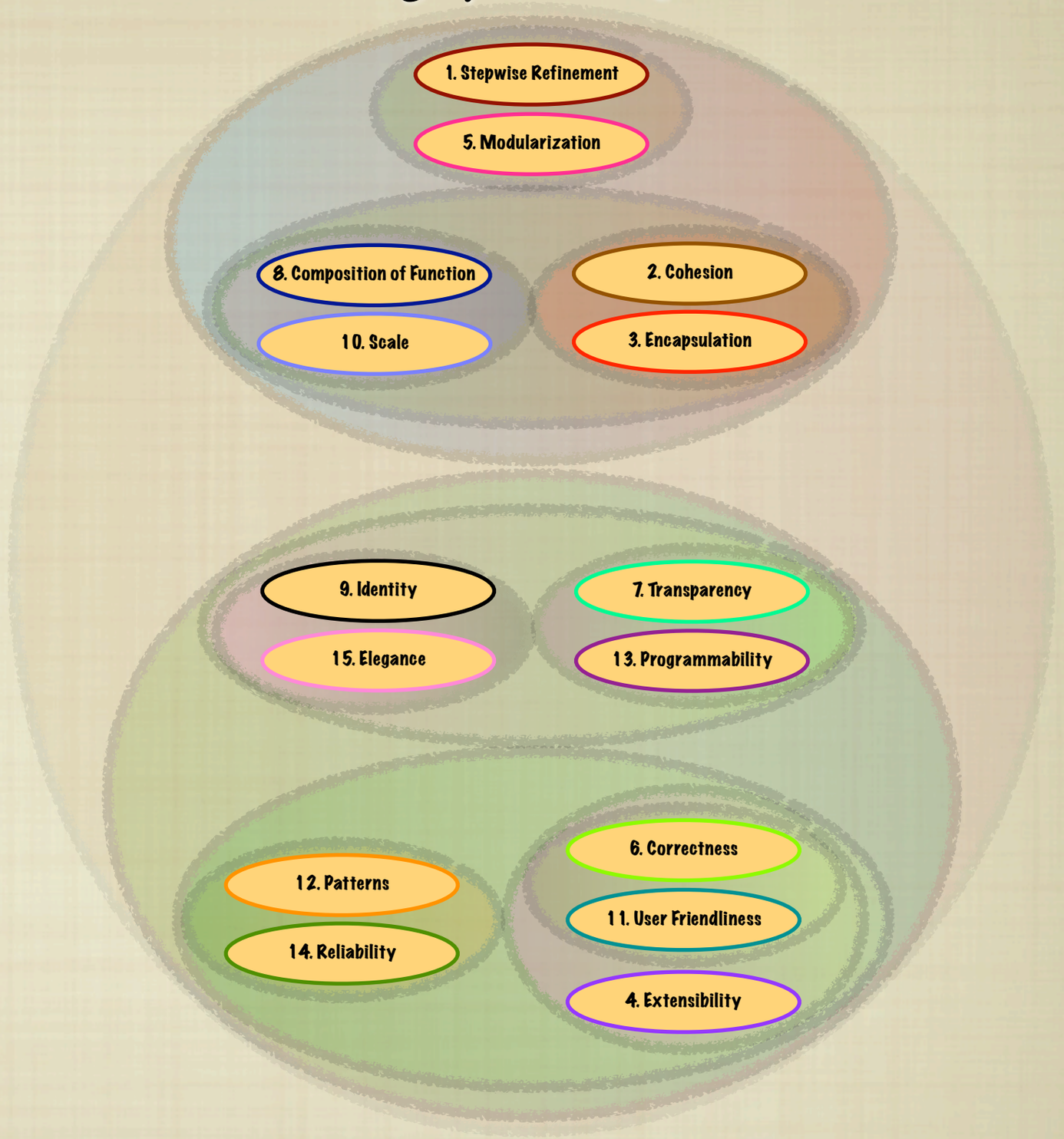
firmitas
strength

venustas
beauty

utilitas
functionality

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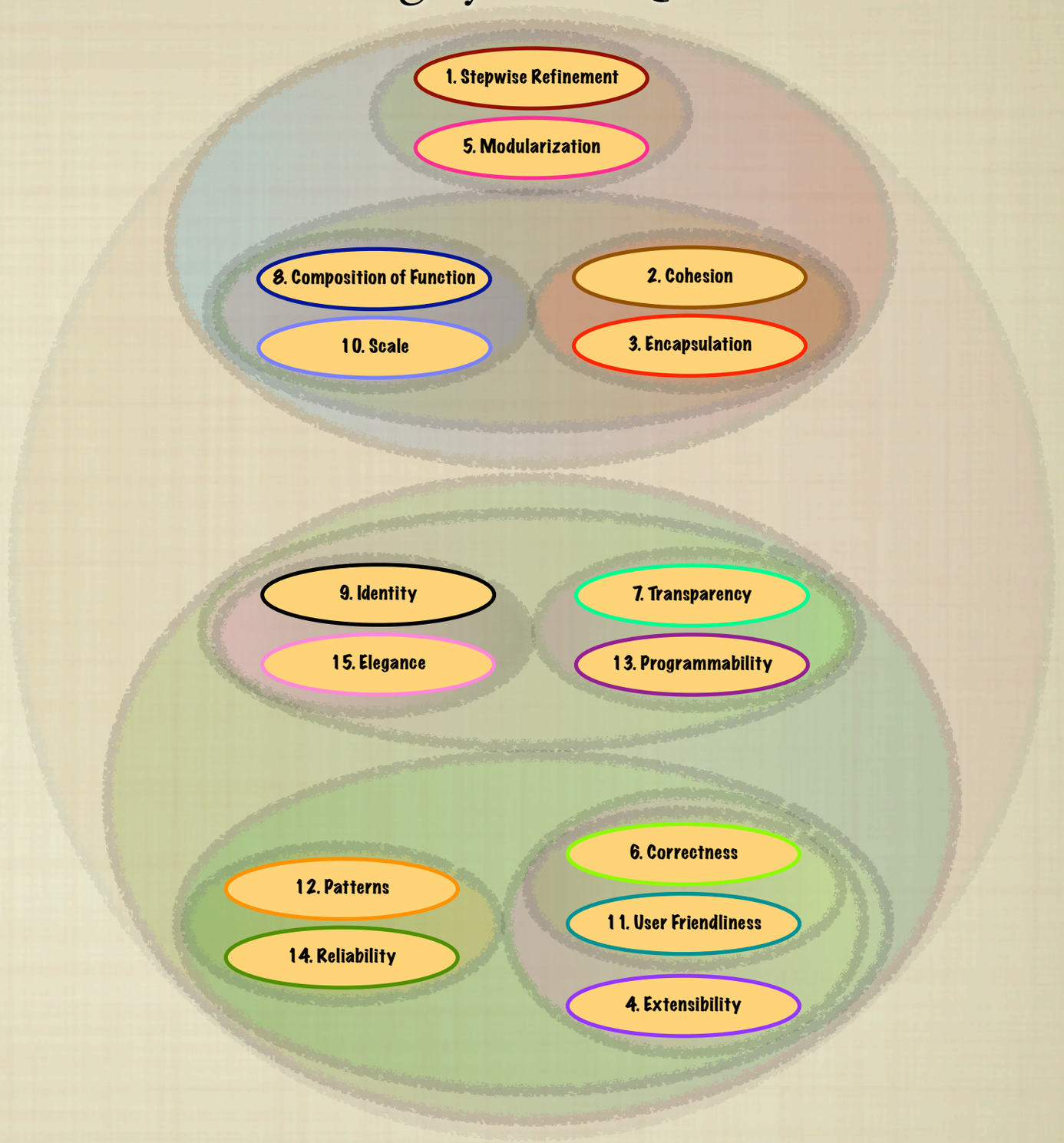
Thriving Systems Qualities



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A Thriving System exhibits the confluence of design qualities described by *robustness* and *vitality* –

Thriving Systems Qualities

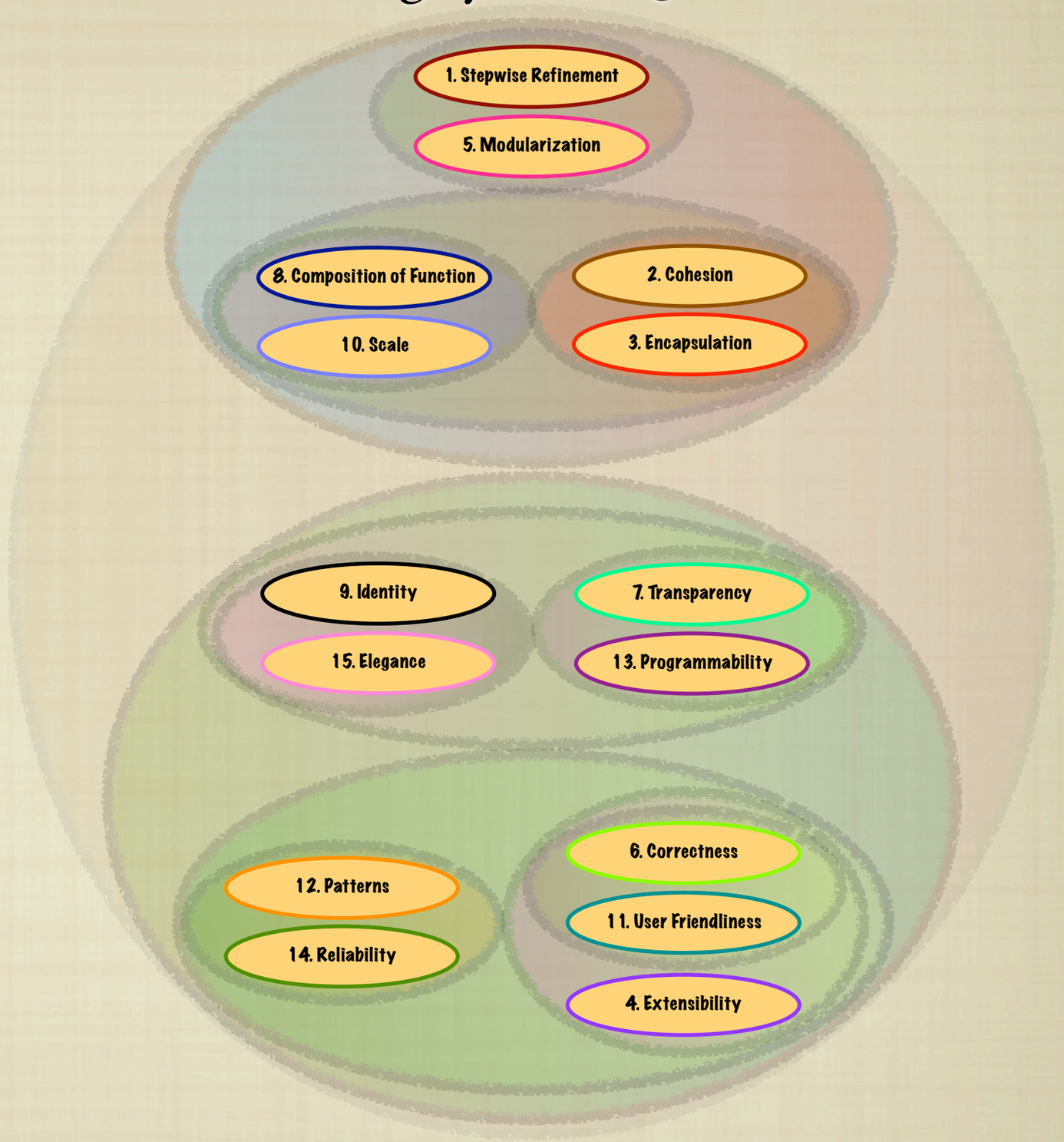


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A Thriving System exhibits the confluence of design qualities described by *robustness* and *vitality* –

beyond existing, beyond functional, beyond surviving.

Thriving Systems Qualities

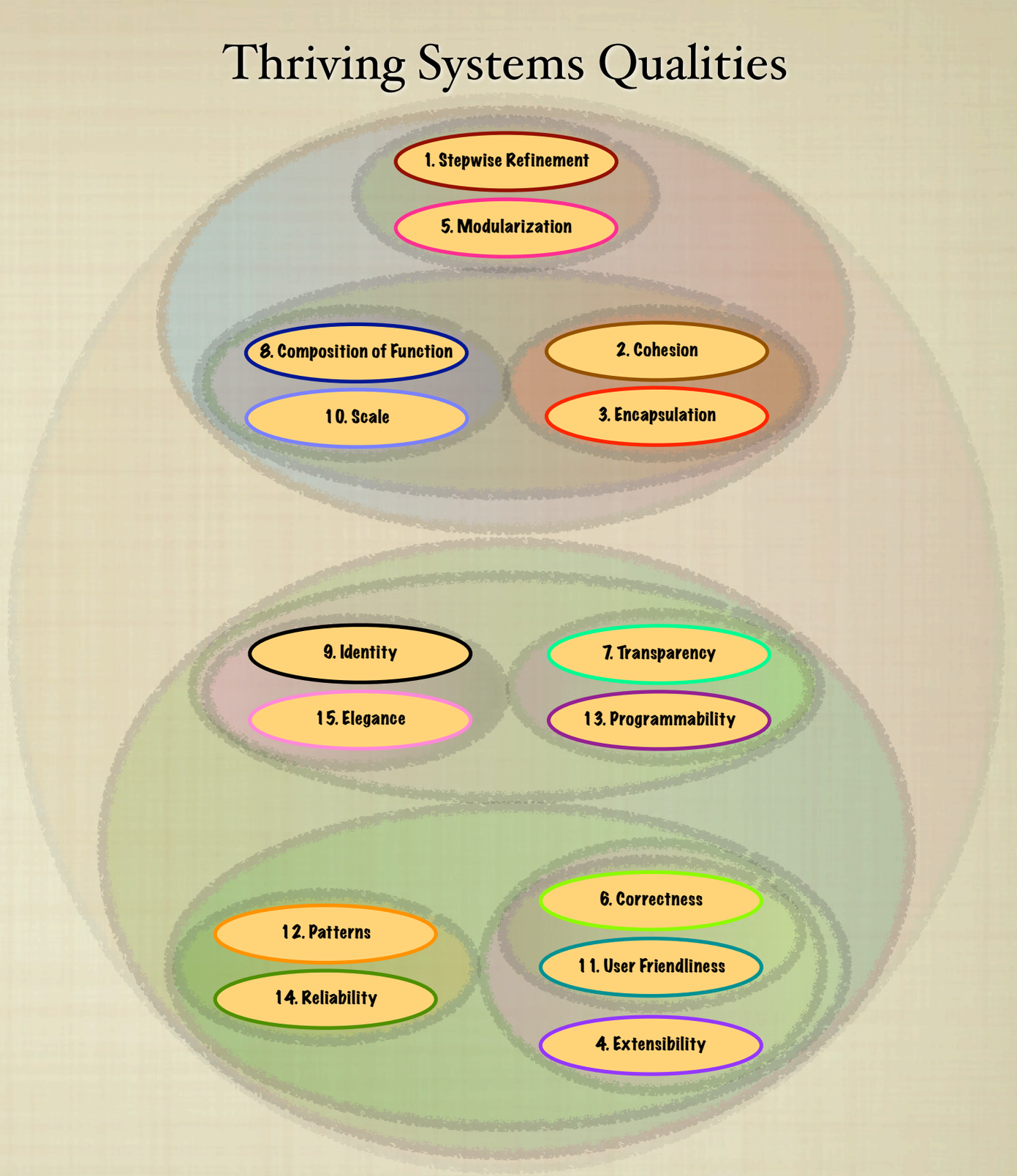


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A Thriving System exhibits the confluence of design qualities described by *robustness* and *vitality* –

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It thrives not only because it supports and aligns with the stakeholders' intentions in the "now," but –



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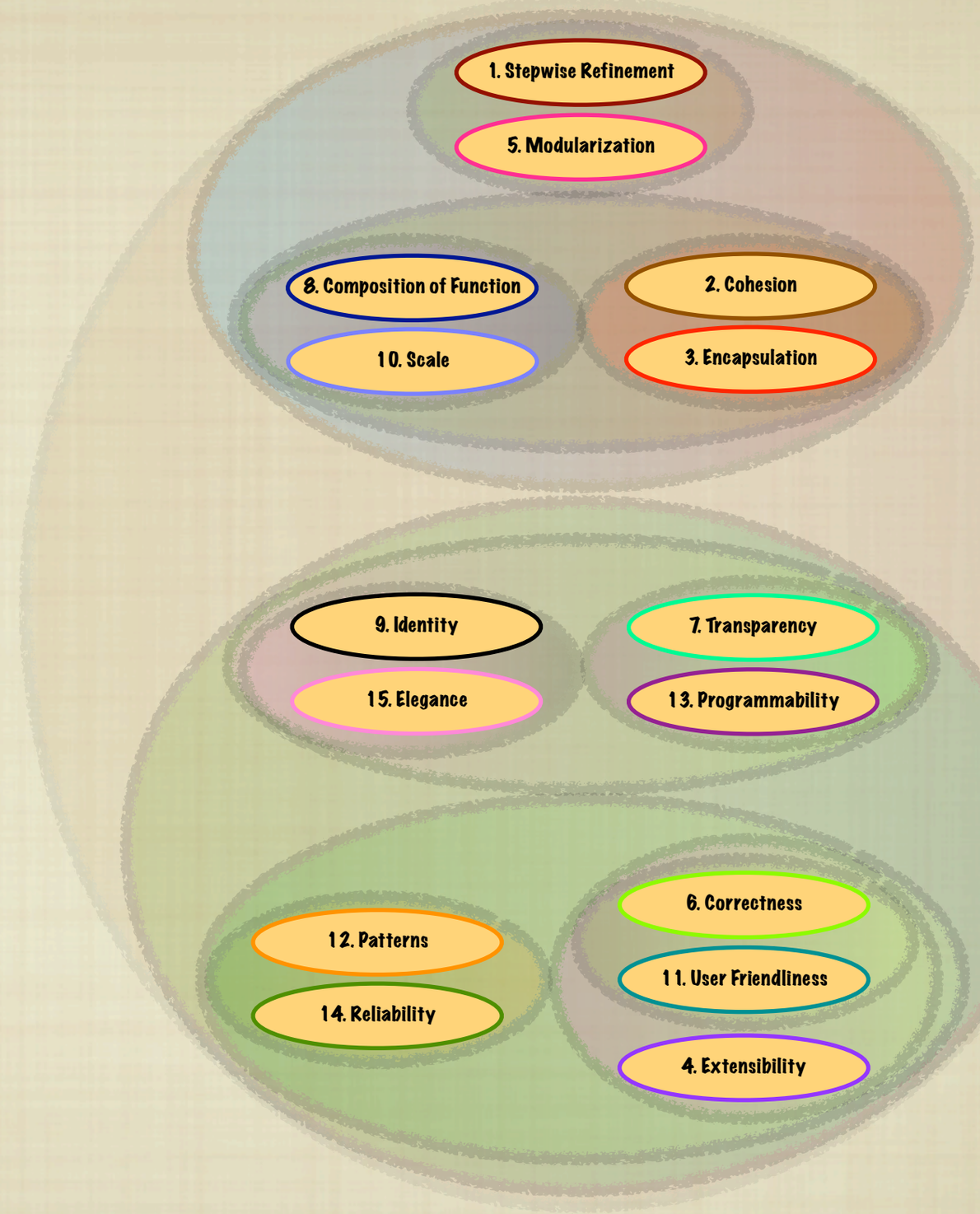
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Thriving Systems Qualities



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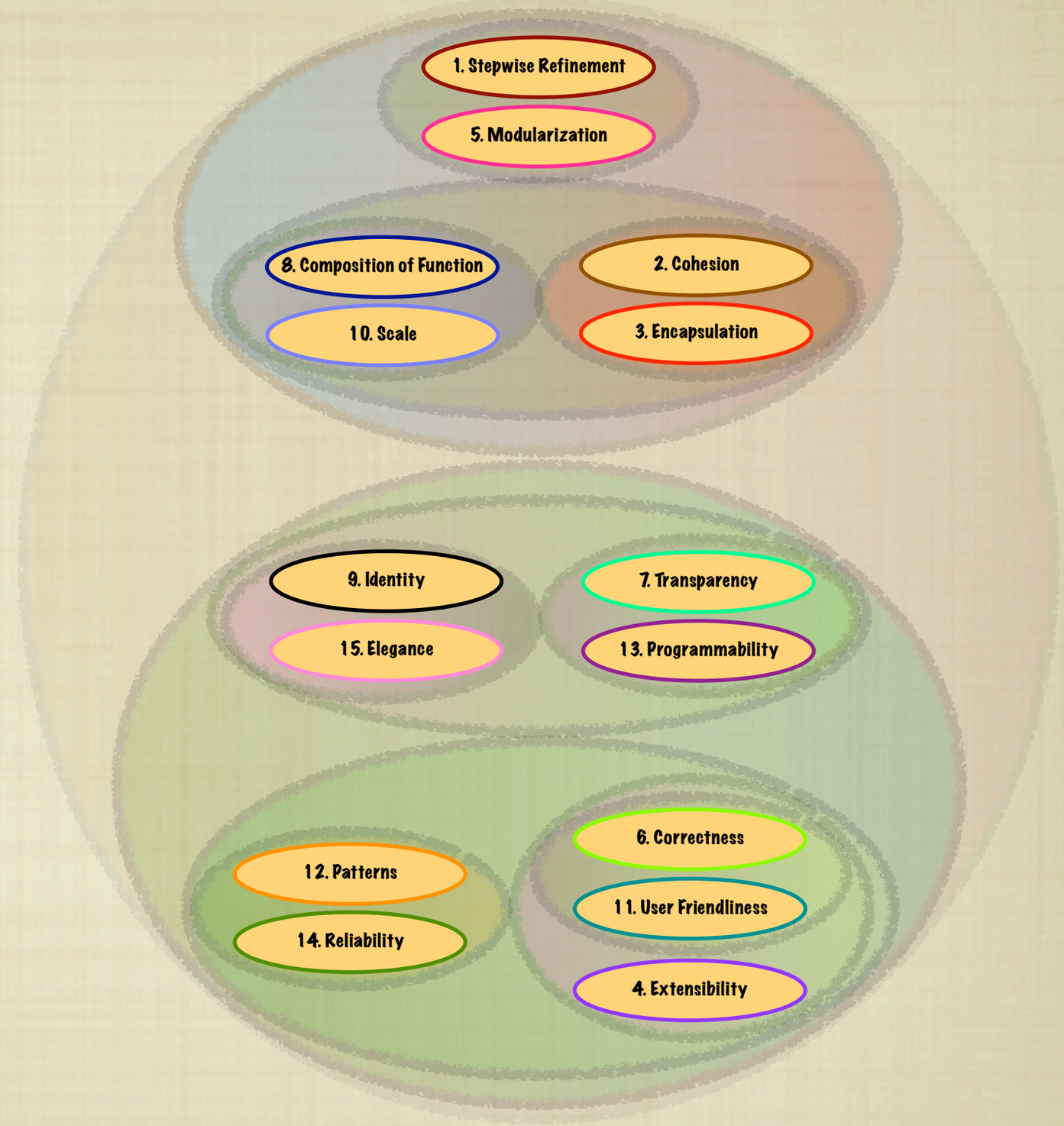
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Great design meets both "fields" of challenge: a model with strength in all the Thriving Systems qualities enumerated above, but inexorably grounded on an authentic representation of stakeholder intentions.

Thriving Systems Qualities



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Shaping A Mindset For Great Design

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Shaping A Mindset For Great Design

- *Perceive the wholeness and the impact of individual design choices on the system as a whole – not only in the static present, but in the dynamic unfolding of the stakeholders' perspectives of life; in the system they will live in.*

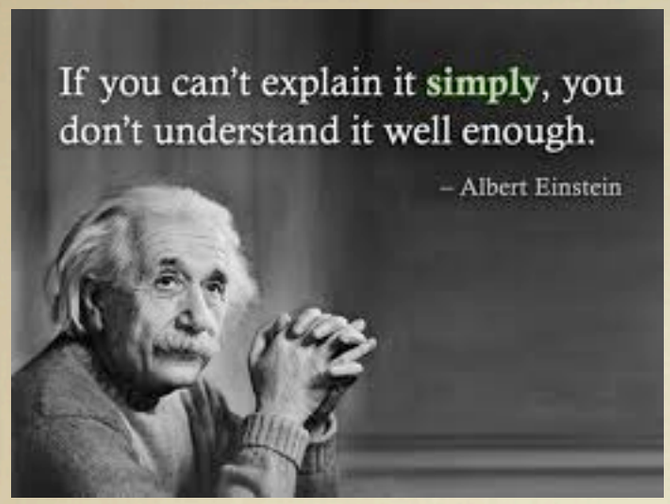
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Shaping A Mindset For Great Design

- *Perceive the wholeness and the impact of individual design choices on the system as a whole – not only in the static present, but in the dynamic unfolding of the stakeholders' perspectives of life; in the system they will live in.*
- *Focus on why you use the modeling tools – not on the tools themselves. Redirect decision-making energy to the questions: "What does life mean to these stakeholders?" and "How does each choice increase the life in the system by fulfilling the stakeholders' evolving concerns?"*

Les Waguespack

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Monograph in Two Parts

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- Thriving Systems Theory
  - a vocabulary of elemental properties describing system elements appropriate to a particular domain
  - a taxonomy of system quality resulting from the interplay of those elemental properties

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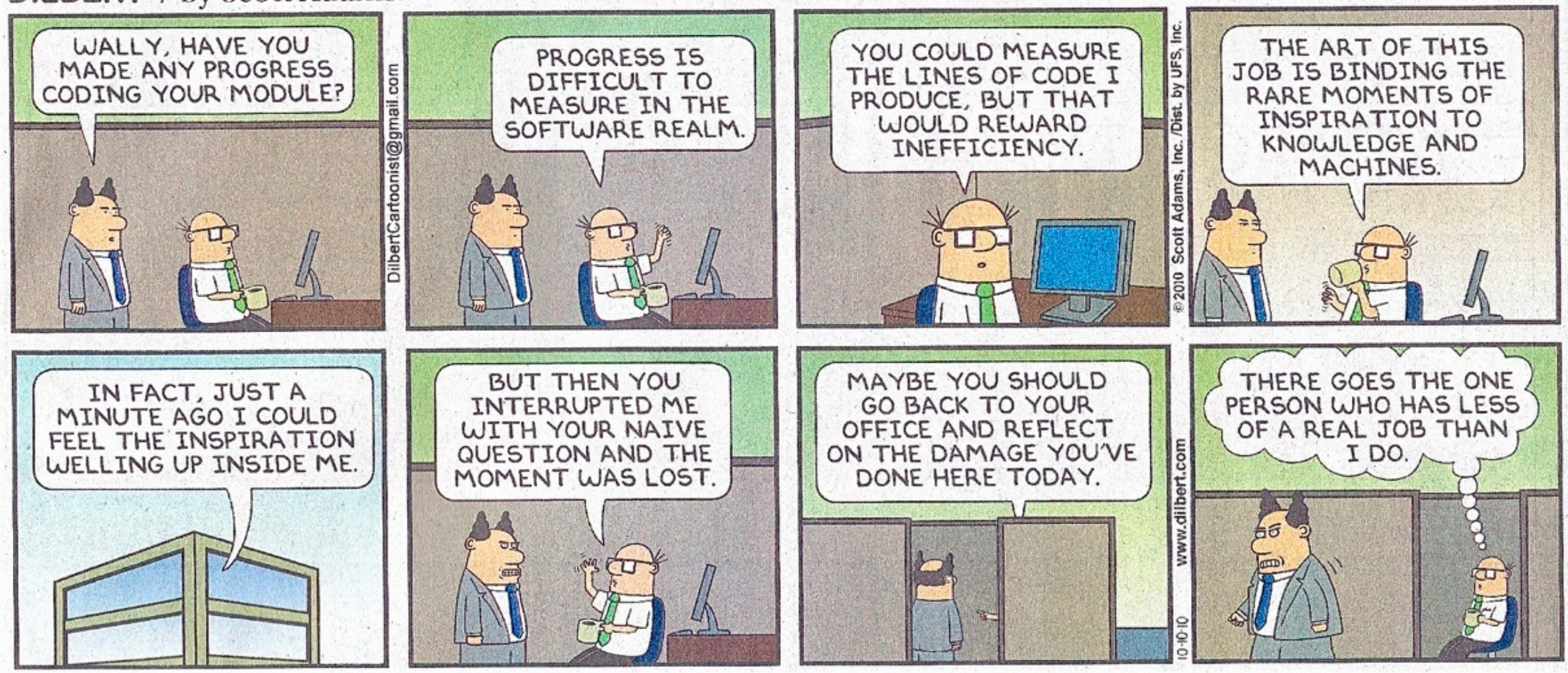
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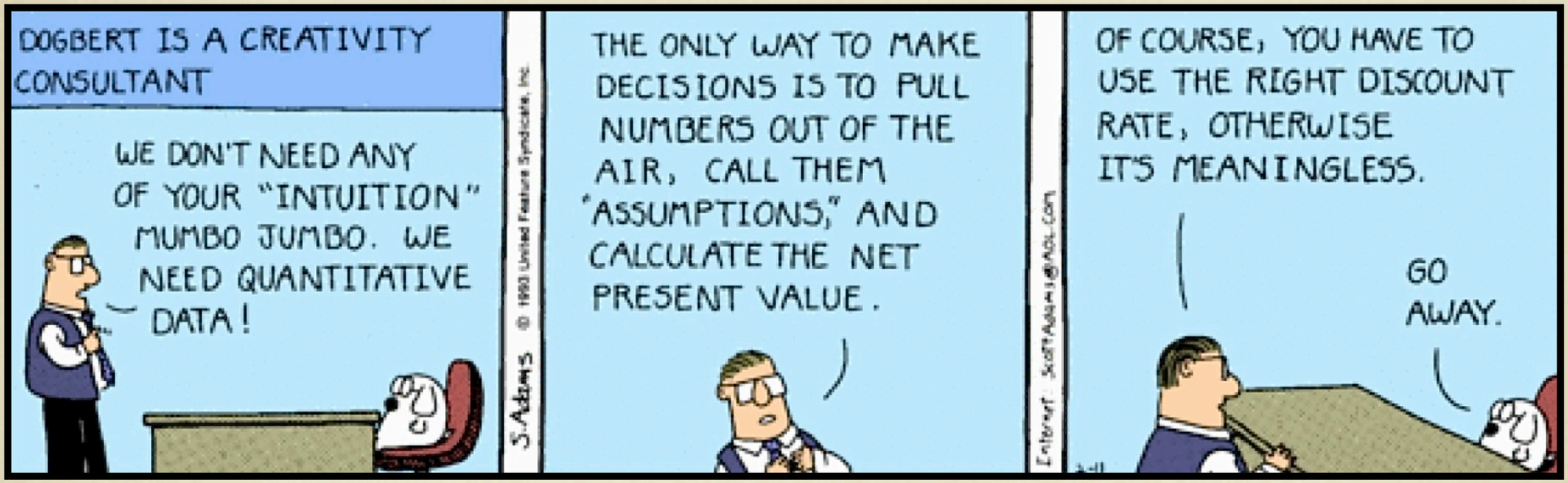
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NEW ENGLAND'S LARGEST NEWSPAPER

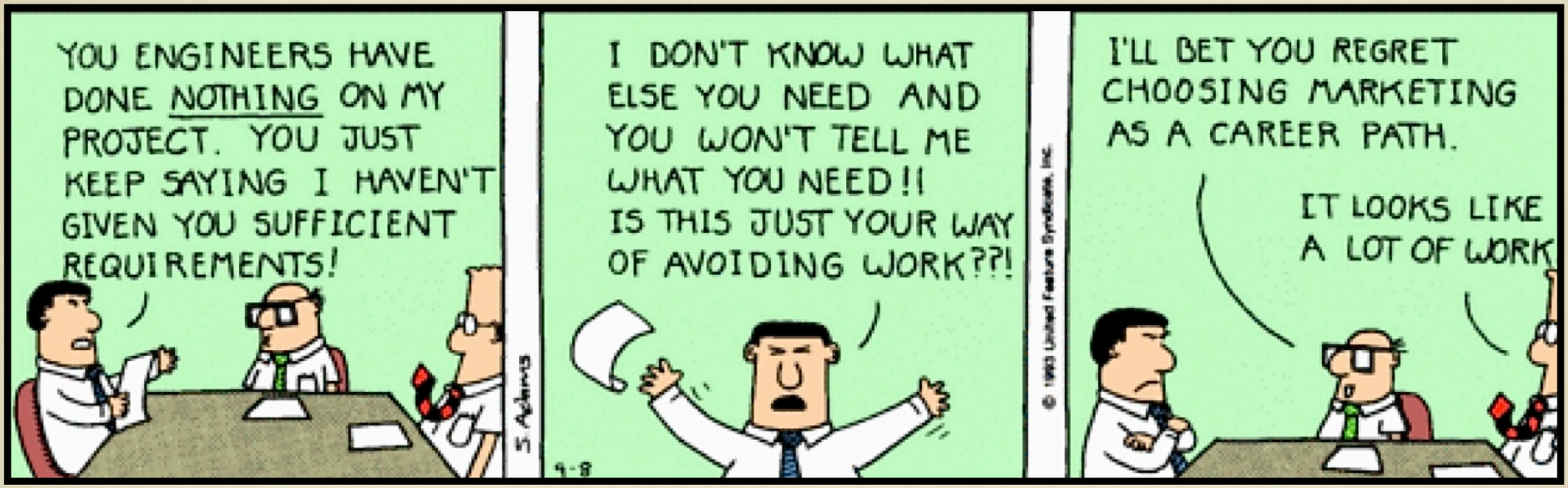
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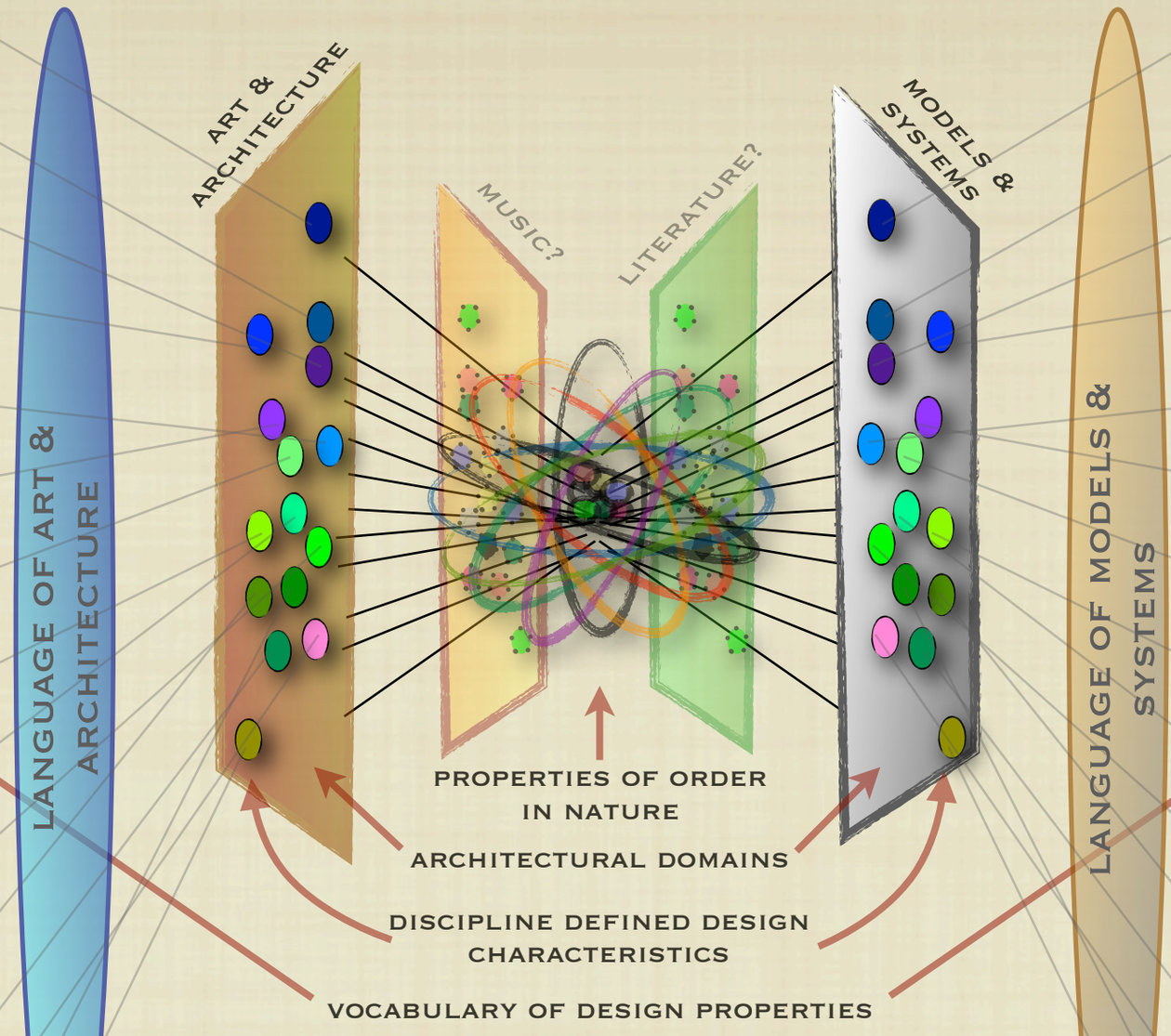
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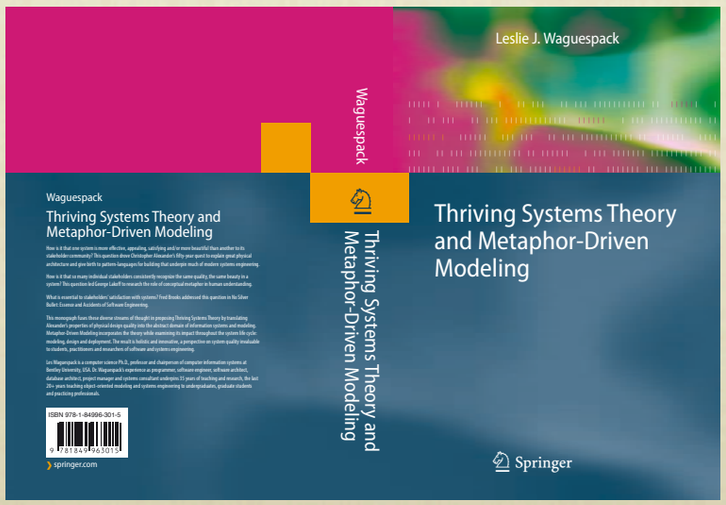
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Thriving Systems Theory

- Levels of Scale
- Positive Space
- Strong Centers
- Boundaries
- Deep Interlock and Ambiguity
- Gradients
- Good Shape
- Roughness
- Alternating Repetition
- Echoes
- Simplicity and Inner Calm
- Local Symmetries
- The Void
- Contrast
- Not Separateness



- Stepwise Refinement
- Modularization
- Cohesion
- Encapsulation
- Composition of Function
- Scale
- Correctness
- User Friendliness
- Extensibility
- Patterns
- Reliability
- Transparency
- Programmability
- Identity
- Elegance



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