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

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School of Computing,
University of South Alabama
Overview of This Talk
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- Inspiring *Thriving Systems Theory*
  - speculating a fundamental and comprehensive taxonomy of system design quality
What do we “see” in great design?
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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 his Silver Bullet Essay and Actions 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 systems life cycle: modeling, design and deployment. The result is both innovative 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 chairman 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.
Monograph in Two Parts
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Thriving Systems Theory
- a vocabulary of elemental properties describing how system elements that convey recognition and satisfaction
- a taxonomy of system quality resulting from the interplay of those elemental properties
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- **Metaphor-Driven Modeling**
  - 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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design what / what design!?
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design (νt): The process of making deliberate formative decisions to create an artifact.
design what / what design!?

design (vt): The process of making deliberate formative decisions to create an artifact.

design (n): The confluence of formative elements that compose an artifact.
What is Design Quality?
What is Design Quality?

- A degree of excellence (Oxford English Dictionary)
- Freedom from deficiencies or defects (Juran 2009)
- Conformity to requirements (Crosby 1979)
- Fitness for use (Juran 2009)
- Fitness for purpose (Sales and supply goods act: UK 1994)
- The degree to which the inherent characteristics fulfill requirements (ISO 9000:2005)

**Sustained satisfaction** (Deming 1993)
the individual’s experience of design quality

implementation  threshold  expectation  mindset
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
the individual’s experience of design quality

implementation

threshold

expectation

mindset

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

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implementation

the point of encounter between the expectation and the system’s features

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implementation ↔ threshold ↔ expectation ↔ mindset
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Thriving Systems Theory
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PROPERTIES OF ORDER
IN NATURE
Thriving Systems Theory

- Properties of order in nature
- Architectural domains
- Discipline defined design characteristics

Art & Architecture
Thriving Systems Theory

- 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

Properties of Order in Nature
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ALEXANDER’S LANGUAGE OF ART & ARCHITECTURE

ART & ARCHITECTURE

MODELS & SYSTEMS

PROPERTIES OF ORDER IN NATURE
ARCHITECTURAL DOMAINS
DISCIPLINE DEFINED DESIGN CHARACTERISTICS
VOCABULARY OF DESIGN PROPERTIES

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Thriving Systems Theory

A Search For Fundamental Principles Of System Design Quality
A Search For Fundamental Principles Of System Design Quality

Fred Brooks’ Essence and Accidents of Information Systems Development
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George Lakoff’s Theories of conceptual Metaphor in Cognition
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Threads of Theory in Design
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Christopher Alexander

Notes on the Synthesis of Form
1964

The Oregon Experiment
1975

A Pattern Language
1977

A Timeless Way of Building
1979

The Phenomenon of Life

The Process of Creating of Life
2002

A Vision of a Living World
2004

The Luminous Ground
2005

Software Engineering
1971

Designing Software for Ease of Extension and Contraction - Parnas
1979

No Silver Bullet: Essence and Accidents of Software Engineering - Brooks
1987

Program Development BY Stepwise Refinement - Wirth

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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.”
George Lakoff’s Theories of Metaphor in Cognition
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Christopher Alexander – *Great Architect*
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OOPSLA 1996 Keynote Speech Introduction by Jim Coplien

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

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!
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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- Centers are distinct but may combine to form nested centers.

- “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)
Center Properties
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- Satisfaction is the degree of “resonance” between a center’s cumulative center properties and the observer.

(Alexander)
Alexander’s 15 Center Properties Expressing Architectural Quality
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- Strong Centers
- Not Separateness
- Boundaries
- Positive Space
- Deep Interlock and Ambiguity
- Good Shape
- Alternating Repetition
- Simplicity and Inner Calm
- The Void
- Levels of Scale
- Gradients
- Roughness
- Echoes
- Local Symmetries
- Contrast
- The Void
Levels of Scale: A strong center is made stronger partly by smaller strong centers contained in it, and partly by its larger strong centers which contain it. A balanced range of sizes is pleasing and beautiful.

Positive Space: A center should draw strength from the centers immediately adjacent. The background should reinforce rather than detract from the center.

Strong Centers: A strong center requires a field-like effect created by other centers. Good design offers areas of focus or weight.

Boundaries: The field-like effect is strengthened by the creation of a ring-like center. Outlines focus attention on the center.

Deep Interlock and Ambiguity: The intensity of a center can be increased when it is attached to nearby strong centers through a third set of strong centers that ambiguously belong to both. Looping, interconnected elements promote unity and grace.

Gradients: A center is strengthened by a graded series of different sized centers which then point to a new center. The proportional use of space and pattern creates harmony.

Local Symmetries: The intensity of a center is increased by the extent to which other smaller centers are themselves arranged in locally symmetrical groups. Organic, small-scale symmetry works better than precise, overall symmetry.

The Void: The intensity of every center depends on the existence of a still place – an empty center. Empty spaces offer calm and contrast.

Good Shape: The strength of a center depends on its actual shape. Its boundaries and the space around it must be made up of strong centers. Simple forms create an intense, powerful center.

Roughness: The way a center draws its strength from irregularities in sizes, shapes and arrangements. Texture and imperfections convey uniqueness and life.

Alternating Repetition: Centers are strengthened when they repeat, by the insertion of other centers between them. Repeating various elements creates a sense of order and harmony.

Echoes: The strength of a given center depends on similarities of angle and orientation. Similarities should repeat themselves throughout a design.

Simplicity and Inner Calm: The strength of a center depends on its simplicity. Use only essentials and avoid extraneous elements.

Alexander’s 15 Centers Properties Expressing Architectural Quality

Contrast: A center is strengthened by the sharpness of distinction between itself and the surrounding centers. Unity is achieved with visible opposites.

Not Separateness: The strength of a center depends on the extent to which that center is merged smoothly with surrounding centers. Designs should be connected and complementary, not egocentric and isolated.
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**Not Separateness:** The strength of a center depends on the extent to which that center is merged smoothly with surrounding centers. Designs should be connected and complementary, not egocentric and isolated.

**Simplicity and Inner Calm:** The strength of a center depends on its simplicity. Use only essentials and avoid extraneous elements.
Alexander’s 15 Centers Properties Expressing Architectural Quality

- **Levels of Scale**: A strong center is made stronger partly by smaller strong centers contained in it, and partly by its larger strong centers which contain it. A balanced range of sizes is pleasing and beautiful.

- **Positive Space**: A center should draw strength from the centers immediately adjacent. The background should reinforce rather than detract from the center.

- **Local Symmetries**: The intensity of a center is increased by the extent to which other smaller centers are themselves arranged in locally symmetrical groups. Organic, small-scale symmetry works better than precise, overall symmetry.

- **Strong Centers**: A strong center requires a field-like effect created by other centers. Good design offers areas of focus or weight.

- **Boundaries**: The field-like effect is strengthened by the creation of a ring-like center. Outlines focus attention on the center.

- **Deep Interlock and Ambiguity**: The intensity of a center can be increased when it is attached to nearby strong centers through a third set of strong centers that ambiguously belong to both. Looping, interconnected elements promote unity and grace.

- **Gradients**: A center is strengthened by a graded series of different sized centers which then point to a new center. The proportional use of space and pattern creates harmony.

- **The Void**: The intensity of every center depends on the existence of a still place – an empty center. Empty spaces offer calm and contrast.

- **Good Shape**: The strength of a center depends on its actual shape. Its boundaries and the space around it must be made up of strong centers. Simple forms create an intense, powerful center.

- **Roughness**: The way a center draws its strength from irregularities in sizes, shapes and arrangements. Texture and imperfections convey uniqueness and life.

- **Alternating Repetition**: Centers are strengthened when they repeat, by the insertion of other centers between them. Repeating various elements creates a sense of order and harmony.

- **Echoes**: The strength of a given center depends on similarities of angle and orientation. Similarities should repeat themselves throughout a design.

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Center Properties
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a vocabulary of design element characteristics that impart the experience of quality in architecture,

“The Nature of Order” discernible in physicality.
Alexander’s 15 Center Properties

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Observable / Attainable

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

**Attainable:** *as in manipulation through design choices*

“Order, Wholeness” can be pursued in design!
“The concept extends to any space where objects & relationships are observed.”

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

Alexander
“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
Center transliterates as Choice in a conceptual world of abstractions
Center transliterates as Choice in a conceptual world of abstractions

Alexander’s concepts are expressed in a vocabulary of physical, visible structure.
Center transliterates as **Choice** in a conceptual world of abstractions

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

- All systems (e.g. IS systems) can be expressed as abstractions analogous to physical structure and relationships.
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Translating the Properties from Centers to Choices
## Translating the Properties from Centers to Choices

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The choice properties propose a coherent, descriptive language including:

- a vocabulary for describing and assessing aspects of design decisions comprising system components, structures, and interrelationships, and
- design actions to guide design choices to achieve desirable system characteristics.
Exploring the plausibility of choice properties
Is there evidence that the choice properties can be identified in systems that are generally accepted as exhibiting great design?
Exploring the plausibility of choice properties

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- Are there modeling actions in design that can intentionally affect the intensities of the various properties of a choice?
Exploring the plausibility of choice properties

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- Are such modeling actions transferable across paradigms of artifacts? - Across paradigms of modeling?
Evidence of Choice Properties in Systems and Modeling
Evidence of Choice Properties in Systems and Modeling

- Choice Properties in Extant Systems
Evidence of Choice Properties in Systems and Modeling

Choice Properties in Extant Systems

APACHE web server (Design Principles & Practices)
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Evidence of Choice Properties in Systems and Modeling

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- Choice Properties Mapped to Modeling
Evidence of Choice Properties in Systems and Modeling

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- Choice Properties Mapped to Modeling
  - ✓ object-oriented modeling  *(monograph Ch12)*
Object-Oriented Ontology

- Object
  - Progeny
  - Encapsulation
  - Membership IN
  - Membership OF

- Class
  - Property
  - Relationship
  - Inheritance

- Variable
  - Data attribute

- Service
  - Behavioral attribute

- Polymorphism
  - Relationship

- Method
  - Behavioral attribute

- Remembrance
  - Property

- Value
  - Data attribute

- Message passing
  - Relationship

- Instance
  - Membership OF

- Identity
  - Property

- Encapsulation
  - Property

- Association
  - Property
Evidence of Choice Properties in Systems and Modeling

- Choice Properties in Extant Systems
  - ✓ APACHE web server  *(Design Principles & Practices)*
  - ❋ network architecture

- Choice Properties Mapped to Modeling
  - ✓ object-oriented modeling  *(monograph Ch12)*
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  - business process modeling

- Other System Domains
Evidence of Choice Properties in Systems and Modeling

- Choice Properties in Extant Systems
  - APACHE web server *(Design Principles & Practices)*
  - network architecture
- Choice Properties Mapped to Modeling
  - object-oriented modeling *(monograph Ch12)*
  - relational modeling *(monograph Ch13)*
  - agile methodology - SCRUM *(HICSS-45)*
- business process modeling
- Other System Domains
  - music
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  - ✓ APACHE web server (Design Principles & Practices)
  - □ network architecture

- Choice Properties Mapped to Modeling
  - ✓ object-oriented modeling (monograph Ch12)
  - ✓ relational modeling (monograph Ch13)
  - ✓ agile methodology - SCRUM (HICSS-45)
  - □ business process modeling

- Other System Domains
  - □ music
  - □ english composition
The Design Process
The Design Process

Stakeholder intentions
requirement elements
model elements
design elements
The Design Process

“rules of thumb”
Traditional patterns

Stakeholder intentions
requirement elements
model elements
design elements

Representational paradigm or Ontology
The Design Process

“rules of thumb”
Traditional patterns

Stakeholder intentions
requirement elements
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Representational paradigm or Ontology

Resulting Design Elements
The Design Process

“rules of thumb”
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Stakeholder intentions
requirement elements
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Resulting Design Elements

Representational paradigm or Ontology

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The Design Process

Choice Property-Driven Design Principles

Stakeholder intentions
requirement elements
model elements
design elements

Representational paradigm or Ontology

Resulting Design Elements
design quality across the system models

implementation  threshold  expectation  mindset
design quality across the system models

implementation  threshold  expectation  mindset

Choice Property-Driven Design Principles
design quality across the system models

implementation
hardware & software architecture

threshold
interfaces

expectation
requirements engineering & specification

mindset
object oriented “systems think”

Choice Property-Driven Design Principles
Pursuing a Universal Foundation of System Design Quality

from the beauty in nature to the quality in systems
Pursuing a Universal Foundation of System Design Quality

from the beauty in nature to the quality in systems

properties of order in nature
Pursuing a Universal Foundation of System Design Quality

from the beauty in nature

system design actions and choice properties

to the quality in systems
Pursuing a Universal Foundation of System Design Quality

from the beauty in nature

elaborate
modularize
factor
encapsulate
assemble
focus
align
accommodate
extend
pattern
normalize
expose
generalize
identify
coordinate

system design actions and choice properties

to the quality in systems

properties of order in nature

Stepwise Refinement
Modularization
Cohesion
Encapsulation
Composition of Function
Scale
Correctness
User Friendliness
Extensibility
Patterns
Reliability
Transparency
Programmability
Identity
Elegance
Pursuing a Universal Foundation of System Design Quality

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coordinate

system design actions and choice properties

object-oriented models that thrive

to the quality in systems

Object-oriented ontology
Pursuing a Universal Foundation of System Design Quality

- elaborate
- modularize
- factor
- encapsulate
- assemble
- focus
- align
- accommodate
- extend
- pattern
- normalize
- expose
- generalize
- identify
- coordinate

from the beauty in nature

properties of order in nature

system design actions and choice properties

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

Object-oriented ontology

Relational data ontology

from the beauty in nature to the quality in systems

object-oriented models that thrive

relational data models that thrive
Pursuing a Universal Foundation of System Design Quality

from the beauty in nature

properties of order in nature

elaborate modularize factor modularize factor

factor

encapsulate assemble

assemble

focus align accommodate

accommodate

extend pattern

extend pattern

normalization expose generalize

expose generalize

identify coordinate

coordinate

system design actions and choice properties

object-oriented models that thrive

relational data models that thrive

to the quality in systems

Relational data ontology

SCRUM ontology

Object-oriented ontology

system design actions and choice properties
Pursuing a Universal Foundation of System Design Quality

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system design actions and choice properties

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Relational data ontology
Object-oriented ontology
SCRUM ontology

Business process modeling vocabulary or ontology?
Toward a Vision of Thriving Systems
"The Nature of Order" is evident in choice properties observable in information systems!
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The translated properties denote design features that may appear to be discrete.
“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?
“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?
Choice Properties

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

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## Property Interaction

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Alexander’s Inter-Property Support Network

- Not Separateness
- Positive Space
- Levels of Scale
- Strong Centers
- Boundaries
- Deep Interlock and Ambiguity
- Gradients
- Good Shape
- Roughness
- Alternating Repetition
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Choice Properties Substituted for Center Properties

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

Stepwise Refinement
## Coherence Analysis

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

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## Coherence Analysis

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

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Choice Properties

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

- A
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  - 5. Modularization
- B
  - 2. Cohesion
  - 3. Encapsulation
- C
  - 8. Composition of Function
  - 10. Scale
- D
  - 6. Correctness
  - 11. User Friendliness
- E
  - 4. Extensibility
  - 12. Patterns
  - 14. Reliability
- F
  - 7. Transparency
  - 13. Programmability
- G
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  - 15. Elegance

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©LJW, 2012 All Rights Reserved
Property Cluster ==> Design Quality
Property Cluster ==> Design Quality

- Each cluster reflects a unique blend of property resonance
Property Cluster ==> Design Quality

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

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

1. Stepwise Refinement
2. Cohesion
3. Encapsulation
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8. Composition of Function
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12. Patterns
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9. Identity
14. Reliability
7. Transparency
15. Elegance
Intra-structural focus

Choice Property Clusters

1. Stepwise Refinement
2. Cohesion
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4. Extensibility
5. Modularization
8. Composition of Function
6. Correctness
10. Scale
11. User Friendliness
4. Extensibility
12. Patterns
14. Reliability
7. Transparency
13. Programmability
9. Identity
15. Elegance
Choice Property Clusters

Intra-structural focus

1. Stepwise Refinement
2. Cohesion
3. Encapsulation
8. Composition of Function
10. Scale

Extra-structural focus

5. Modularization
6. Correctness
11. User Friendliness
4. Extensibility
12. Patterns
14. Reliability
7. Transparency
13. Programmability
9. Identity
15. Elegance
Design Cluster Naming
5. Modularization

Goal-directed decomposition reflects stakeholder perception of relationships among concepts. Parts are essential to the distribution and tolerance of complexity.
Design Cluster Naming

1. Stepwise Refinement

5. Modularization

Divisibility
Design Cluster Naming

- Divisibility
- 1. Stepwise Refinement
- 2. Cohesion: cohesion reflects choice self-sufficiency: well-formed with cogency
- 3. Encapsulation: encapsulation bounds but also interfaces the choice to the surrounding collection
- 5. Modularization
Design Cluster Naming

Divisibility

1. Stepwise Refinement
2. Cohesion
3. Encapsulation
5. Modularization

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

scale reflects a useful granularity of attention or focus
Design Cluster Naming

Divisibility

1. Stepwise Refinement
2. Cohesion
3. Encapsulation

Constructibility

5. Modularization
8. Composition of Function
10. Scale

Factorability
Design Cluster Naming

Divisibility

1. Stepwise Refinement
   5. Modularization

Constructibility

8. Composition of Function

2. Cohesion

3. Encapsulation

10. Scale

Factorability

soundness of individuals, internal stability and structural independence

opportunity of combining to build larger/more capable arrangements
Design Cluster Naming

Divisibility

Constructibility

Scalability

1. Stepwise Refinement
2. Cohesion
3. Encapsulation
5. Modularization
8. Composition of Function
10. Scale

Factorability
Design Cluster Naming

Divisibility

Constructibility

Scalability

1. Stepwise Refinement
2. Cohesion
3. Encapsulation
5. Modularization
8. Composition of Function
10. Scale

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
Design Cluster Naming

1. Stepwise Refinement
2. Cohesion
3. Encapsulation
5. Modularization
8. Composition of Function
10. Scale
Design Cluster Naming

Divisibility

Constructibility

Scalability

Robustness

Factorability

1. Stepwise Refinement
2. Cohesion
3. Encapsulation
5. Modularization
8. Composition of Function
10. Scale
6. Correctness
11. User Friendliness

choice alignment with intentions (dynamically)
a perception of “what is natural,” “seeing” what you expect reinforces reliance and trust
Design Cluster Naming

- Divisibility
- Constructibility
- Scalability
- Robustness
- Factorability

1. Stepwise Refinement
2. Cohesion
3. Encapsulation
4. Composition of Function
5. Modularization
10. Scale
6. Correctness
7. Patterns
11. User Friendliness
8. Robustness
9. Confidence
12. Proven formulae or techniques enable repeatable success
13. Consistently safe practice continues success with compatible challenges
14. Reliability
Design Cluster Naming

Divisibility

Constructibility

Scalability

Robustness

Factorability

5. Modularization
1. Stepwise Refinement

2. Cohesion
3. Encapsulation

8. Composition of Function

10. Scale

6. Correctness
11. User Friendliness

12. Patterns
14. Reliability

Predictability

Confidence

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Design Cluster Naming

Divisibility

Robustness

Constructibility

Factorability

Scalability

Predictability

keeping “technology” out of the way of intentions

enabling users to recognize then apply choices to their needs
Design Cluster Naming

1. Stepwise Refinement
2. Cohesion
3. Encapsulation
4. Scale
5. Modularization
6. Correctness
7. Transparency
8. Composition of Function
9. Factorability
10. Scale
11. User Friendliness
12. Patterns
13. Programmability
14. Reliability

Divisibility
Constructibility
Scalability
Predictability
Robustness
Factorability
Usability
Confidence
fusing the conceptual with the linguistic (concise, precise, clear, distinct)
realizing resonance between choice and intentions like the “ring” in a chord
Design Cluster Naming

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

Divisibility
Constructibility
Scalability
Intuitiveness
Predictability
Robustness
Factorability
Usability
Confidence
Design Cluster Naming

- Divisibility
  - Constructibility
  - Scalability
- Intuitiveness
- Predictability

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

achieving confidence in the “now”

enabling alignment into the future to embrace change
Design Cluster Naming

Divisibility

Constructibility

Scalability

Intuitiveness

Predictability

Robustness

Factorability

Usability

Confidence

Fidelity

1. Stepwise Refinement

2. Cohesion

3. Encapsulation

4. Extensibility

5. Modularization

6. Correctness

7. Transparency

8. Composition of Function

9. Identity

10. Scale

11. User Friendliness

12. Patterns

13. Programmability

14. Reliability

15. Elegance
Design Cluster Naming

- **Divisibility**
  - 5. Modularization
  - 1. Stepwise Refinement
- **Constructibility**
  - 8. Composition of Function
  - 2. Cohesion
  - 3. Encapsulation
- **Scalability**
  - 10. Scale
- **Robustness**
  - 6. Correctness
- **Factorability**
  - 4. Extensibility
  - 12. Patterns
- **Usability**
  - 7. Transparency
  - 13. Programmability
  - 9. Identity
- **Predictability**
  - 15. Elegance
  - **Fidelity**
  - 14. Reliability
- **Confidence**
  - 11. User Friendliness
  - 1. Predictability

- Usability is the ease with which the user can grasp and apply a choice.
- Intuitiveness expresses the "naturalness" of the choice's expression of the intention it is supposed to represent (or implement).
Design Cluster Naming

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

Divisibility
Constructibility
Scalability
Intuitiveness
Effectiveness
Predictability
Robustness
Factorability
Usability
Confidence
Fidelity

Efficiency
Predictability
Confidence
Fidelity
Design Cluster Naming

- **Divisibility**
  - 1. Stepwise Refinement
  - 5. Modularization
  - 8. Composition of Function
  - 10. Scale
  - 12. Patterns
  - 14. Reliability

- **Constructibility**
  - 2. Cohesion
  - 3. Encapsulation
  - 9. Identity
  - 15. Elegance

- **Scalability**
  - 6. Correctness
  - 7. Transparency
  - 11. User Friendliness
  - 13. Programmability

- **Intuitiveness**
  - 4. Extensibility
  - 14. Reliability

- **Effectiveness**
  - 1. Stepwise Refinement
  - 5. Modularization
  - 8. Composition of Function
  - 10. Scale
  - 12. Patterns
  - 14. Reliability

- **Robustness**
  - 6. Correctness
  - 7. Transparency
  - 11. User Friendliness
  - 13. Programmability

- **Factorability**
  - 1. Stepwise Refinement
  - 5. Modularization
  - 8. Composition of Function
  - 10. Scale
  - 12. Patterns
  - 14. Reliability

- **Usability**
  - 1. Stepwise Refinement
  - 5. Modularization
  - 8. Composition of Function
  - 10. Scale
  - 12. Patterns
  - 14. Reliability

- **Confidence**
  - 1. Stepwise Refinement
  - 5. Modularization
  - 8. Composition of Function
  - 10. Scale
  - 12. Patterns
  - 14. Reliability

**Fidelity**
- fidelity anchors choices in intentions
- predictability fosters choice evolution with anticipated intentions, enabling long-term viability
Design Cluster Naming

- **Divisibility**
  - 1. Stepwise Refinement
  - 5. Modularization

- **Constructibility**
  - 8. Composition of Function
  - 10. Scale

- **Scalability**
  - 2. Cohesion
  - 3. Encapsulation

- **Intuitiveness**
  - 11. User Friendliness
  - 13. Programmability

- **Effectiveness**
  - 9. Identity
  - 14. Reliability

- **Predictability**
  - 12. Patterns
  - 15. Elegance

- **Robustness**
  - 6. Correctness
  - 7. Transparency

- **Factorability**
  - 4. Extensibility

**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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Design Cluster Naming

Divisibility

Constructibility

Robustness

Factorability

Usability

Vitality

Predictability

Sustainability

Fidelity

1. Stepwise Refinement
2. Cohesion
3. Encapsulation
4. Extensibility
5. Modularization
8. Composition of Function
9. Identity
10. Scale
11. User Friendliness
12. Patterns
13. Programmability
14. Reliability
15. Elegance

Robustness: soundness of structure, integrity of form, capacity for stability

Vitality: alignment with stakeholder intentions, capacity for useful growth and unfolding over time

Living Structure
Vitruvius
De architectura
78 BC

1. Stepwise Refinement
5. Modularization

2. Cohesion
3. Encapsulation

4. Extensibility
8. Composition of Function
10. Scale

11. User Friendliness
12. Patterns
14. Reliability

13. Programmability
15. Elegance

6. Correctness
7. Transparency

9. Identity

Robustness
Thriving
Vitality
Vitruvius
De architectura
78 BC

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

firmitas
strength

venustas
beauty

utilitas
functionality
Thriving Systems Qualities

1. Stepwise Refinement
2. Cohesion
3. Encapsulation
4. Extensibility
5. Modularization
6. Correctness
7. Transparency
8. Composition of Function
9. Identity
10. Scale
11. User Friendliness
12. Patterns
13. Programmability
14. Reliability
15. Elegance
A Thriving System exhibits the confluence of design qualities described by *robustness* and *vitality* –
A Thriving System exhibits the confluence of design qualities described by robustness and vitality – beyond existing, beyond functional, beyond surviving.
A Thriving System exhibits the confluence of design qualities described by *robustness* and *vitality* —

*beyond existing, beyond functional, beyond surviving.*

It thrives not only because it supports and aligns with the stakeholders’ intentions in the “now,” but —
Thriving Systems Qualities

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

beyond existing, beyond functional, beyond surviving.

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

It actually promotes the unfolding of those intentions through the conceptual clarity and efficiency with which it represents them – the symbiosis that great design has with an authentic requirement.
A Thriving System exhibits the confluence of design qualities described by *robustness* and *vitality* –

\[ \textit{beyond existing, beyond functional, beyond surviving}. \]

It thrives not only because it supports and aligns with the stakeholders‘ intentions in the “now,” but –

It actually promotes the unfolding of those intentions through the conceptual clarity and efficiency with which it represents them – the symbiosis that great design has with an authentic requirement.

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.
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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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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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?”
Monograph in Two Parts
Monograph in Two Parts

- Thriving Systems Theory
  - a vocabulary of elemental properties describing how system elements that convey recognition and satisfaction
  - a taxonomy of system quality resulting from the interplay of those elemental properties
Monograph in Two Parts

- Thriving Systems Theory
  - a vocabulary of elemental properties describing how system elements that convey recognition and satisfaction
  - a taxonomy of system quality resulting from the interplay of those elemental properties

- Metaphor-Driven Modeling
  - 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
Monograph in Two Parts

Thriving Systems Theory
- a vocabulary of elemental properties describing how system elements that convey recognition and satisfaction
- a taxonomy of system quality resulting from the interplay of those elemental properties

Metaphor-Driven Modeling
- 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
WALLY, HAVE YOU MADE ANY PROGRESS CODING YOUR MODULE?

PROGRESS IS DIFFICULT TO MEASURE IN THE SOFTWARE REALM.

YOU COULD MEASURE THE LINES OF CODE I PRODUCE, BUT THAT WOULD REWARD INEFFICIENCY.

THE ART OF THIS JOB IS BINDING THE RARE MOMENTS OF INSPIRATION TO KNOWLEDGE AND MACHINES.

IN FACT, JUST A MINUTE AGO I COULD FEEL THE INSPIRATION WELLING UP INSIDE ME.

BUT THEN YOU INTERRUPTED ME WITH YOUR NAIVE QUESTION AND THE MOMENT WAS LOST.

MAYBE YOU SHOULD GO BACK TO YOUR OFFICE AND REFLECT ON THE DAMAGE YOU'VE DONE HERE TODAY.

THERE GOES THE ONE PERSON WHO HAS LESS OF A REAL JOB THAN I DO.
Dogbert is a Creativity Consultant

We don't need any of your "intuition" mumbo jumbo. We need quantitative data!

The only way to make decisions is to pull numbers out of the air, call them "assumptions," and calculate the net present value.

Of course, you have to use the right discount rate, otherwise it's meaningless.

Go away.
YOU ENGINEERS HAVE DONE NOTHING ON MY PROJECT. YOU JUST KEEP SAYING I HAVEN'T GIVEN YOU SUFFICIENT REQUIREMENTS!

I DON'T KNOW WHAT ELSE YOU NEED AND YOU WON'T TELL ME WHAT YOU NEED!! IS THIS JUST YOUR WAY OF AVOIDING WORK??!

I'LL BET YOU REGRET CHOOSING MARKETING AS A CAREER PATH.

IT LOOKS LIKE A LOT OF WORK...
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.