Understanding the Complexity of Design

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Introduction

Targeted Approaches to Complexity in Design

Computational Complexity

This is almost a purely algorithmic approach which is often applied on computer science.

Targeted Approaches to Complexity in Design

Complexity in Axiomatic Design

Real Complexity

A measure of uncertainty in achieving the specified functional requirements.

Imaginary Complexity

The uncertainty associated with a designer's lack of knowledge.

Targeted Approaches to Complexity in Design

Measuring Design Problem Complexity

Underlying Assumption

"The more coupled the design problem, the more complex it is."

- Look for interaction among design variables and targets.
- May be modelled by a series of linear equations where distance of the coefficients from the diagonal is an indicator of complexity.

Targeted Approaches to Complexity in Design

Measuring Artifact Complexity

Measuring the complexity of engineering artifacts may serve as a surrogate for problem or solution complexity.

In the case where a standard framework (or system) is used, artifact complexity can be gauged based on the effort required to document it.

Rosen's Approach

Impredicativities in Science

Formalism

In any apparently predictive formalism the application of certain larger contexts generated impredicativities that the original formalism cannot handle.

Classic Example

This statement is false.

"If the statement is true, then it is not false, but if it is not false, then it must be true, but it cannot be true because it says it is false, but if that is true, then it *is* false, but, but, but. . . *ad infinitum*."

Rosen's Approach

Implications for Technology and Design

The Human Factor

"In design, the semantic, non-rational, non-algorithmic, impredicative, subjective, and unpredictable nature of humanity is inescapable, because artifacts are always designed for human use, usually designed by humans themselves, and situated within a larger context of a complex world economy."

In the author's view it is not surprising that design based on a Newtonian perspective have failed to achieve sufficient maturity. The suggested alternative is to assume that design is complex.

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History and Overview

The emergence of the science of complexity is largely credited to these realizations:

1. many interesting and unsolved problems are complex in nature,
2. complexity spans a wide variety of problem domains, and
3. complexity itself is an area worth studying.

Complex System

A large group of strongly interacting parts exhibiting nonlinear dynamical behavior.

May be classified as non-adaptive or adaptive.

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Complex Adaptive Systems

Complex systems seem to operate in the following cycle:

1. coarse graining of information from the real world
2. identification of perceived regularities
3. compression into a schema
4. variation of schema
5. use of the schema
6. selection pressures affecting competition

The definition presented seems to indicate that complex adaptive systems violate the law of entropy. However, it is pointed out that CAS are open systems, exchanging energy with their environment. And some energy is used to change their internal state. Lastly it is pointed out that entropy only applies to closed systems, which resolves the apparent contradiction. CAS can often decrease entropy.

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The Designer-Artifact-User Complex System

This model encompasses the three major subsystems of a *design system*,

1. the designer(s) of the artifact,
2. the artifact(s) being designed, and
3. the user(s) of the artifact.

- DAU system is situated in a larger environment
- Each subsystem (D-A-U) may not be singular

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DAU as a CAS

The authors establish the basis for accepting DAU as a complex adaptive system by considering each phase of the cycle.

Properties of Affordances

Summary

Example of columns 1

Contents of the first column

Contents split
into two lines

Example of columns 2

Contents of first column
split into two lines

Block Types

This is a Block

This is important information

This is an Alert block

This is an important alert

This is an Example block

This is an example

Questions?