Systemic Framework for Enterprise Architecture & Transformation

Theoretical Foundations

Introduction

- This document is an integral component of the SysFEAT architectural framework. It provides foundations to address the challenges posed by Enterprise Architecture in the 21st century, which include :
  - Increasing complexity in system structures and behaviors.
  - Growing intricacy in architecture, management and governance of these systems.
  - The mission of the framework is to demystify these complexities, ensuring they are comprehensible to a broad audience, thereby facilitating the design and management of complex-systems across all scales, from micro-systems to enterprise level systems.

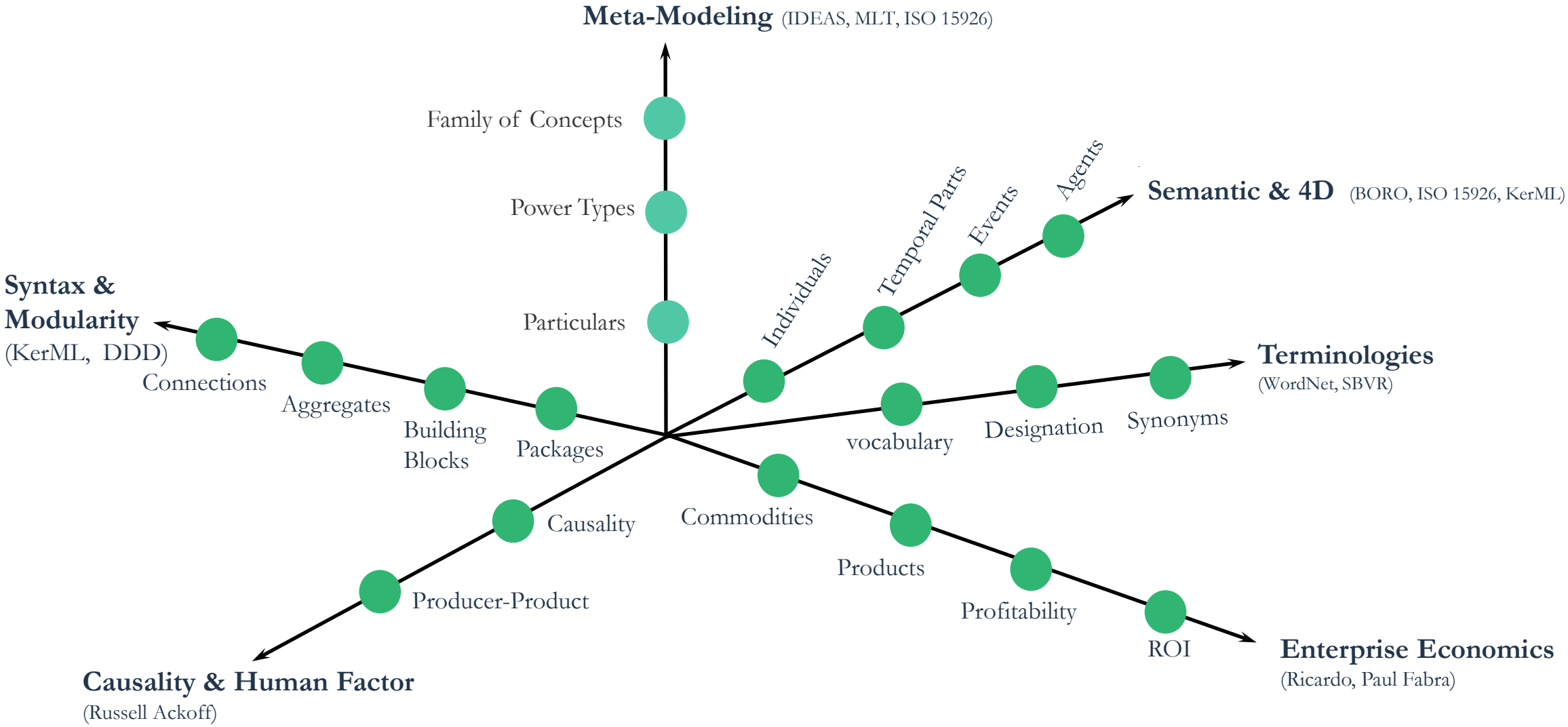
- Enterprise Modeling refers to the overarching language and conceptual framework used to describe, understand, and communicate the complex structures and dynamics of an enterprise and its sub-systems.

- The following slides present the **theoretical foundations** used by SysFEAT to establish the discipline of enterprise and system modeling.

Introduction – a federation on ontology initiatives

- SysFeat contributes to conceptual modeling and ontology-based enterprise architecture by integrating multiple theoretical and standard foundations into a coherent, systemic framework.
- It extends established modeling standards such as ISO 15926, BORO, KerML, IDEAS, and SBVR by introducing compositionality, lexical scoping, and modularity as first-class principles for handling locality, context, and abstraction.
- SysFeat bridges semantic, syntactic, and metamodeling layers—linking ontology with formal syntax (via KerML) and higher-order meta-modeling (via power types and non-well-founded set theory). Its 4D semantic grounding builds on ISO 15926, BORO and Matthew West’s work to capture temporal and extensional identity.
- In doing so, SysFeat provides a unifying meta-ontological foundation that harmonizes and extends existing standards to better model, reason about, and manage the complexity of socio-technical and enterprise systems

Foundations for SysFEAT



Terminology

“To name things wrongly is to add to the misfortune of the world.”
— Albert Camus (related sentiment)

WordNet resource

- Before building a domain ontology, provide a **head start** so you aren't starting from scratch with every concept and relationship WordNet acts as a **semantic scaffold**:
- Essentially, it gives you a **head start** so you aren't starting from scratch with every concept and relationship.

  - It helps define **classes and subclasses**.
  - It disambiguates **word senses**.
  - It expands **vocabulary and synonyms**.
  - It ensures **semantic consistency**.
  - It supports **inference and reasoning** once the ontology is operational.

- SysFEAT wordnet resources: https://www.framework.sysfeat.com/pages/0ffefae6600be4de.htm

Example: "Is Human a Sub-Type of Person ?"

- Looking at "*Person*" in WordNet: https://en-word.net/ili/i35562
- Looking at "*Human*" in WordNet: https://en-word.net/ili/i48657
  - => they are synonyms when considered as singular entities and unrelated when looking at biological classification.
- Lesson learned: **don't start from a blank page !**

Person

Nouns

(n) individual, mortal, person, somebody, someone, soul *a human being; person, singular, assertive existential pronoun; pronoun, person, singular; quantifier: assertive existential "there was too much for one person to do"*

- Hypernyms (1)
- Hyponyms (60)
- Derived Forms (4)
- Holonyms (member) (1)
- Meronyms (part) (2)

Human

Nouns

(n) homo, human, human being, man *any living or extinct member of the family Hominidae characterized by superior intelligence, articulate speech, and erect carriage*

- Hypernyms (1)
  - (n) hominid *a primate of the family Hominidae*
    - Hypernyms (1)
    - Hyponyms (7)
    - Derived Forms (1)
    - Holonyms (member) (1)

SBVR - Semantics of Business Vocabulary and Business Rules

- SBVR in an OMG specification about "*documenting the semantics of business vocabularies and business rules for the exchange of business vocabularies and business rules among organizations and between software tools.*"

- Key concepts introduced by SBVR:
  - **Designation**: The formal link between a concept and the terms or phrases that represent it.
  - **Synonymy**: The explicit recognition that different terms can designate the same concept.
  - **Vocabulary & Speech Communities**: Emphasizes that meaning is defined within the context of a specific community that shares a common language (vocabulary)."

- SysFEAT references to SBVR: https://www.framework.sysfeat.com/pages/732afa5663d7d175.htm

Modularity & Compositionality
Why?

Complexity is good; It is confusion that is bad

Don Norman

The DESIGN of EVERYDAY THINGS

The need for syntax: scientific foundations

- Holland, John H.. Signals and Boundaries: Building Blocks for Complex Adaptive Systems (The MIT Press) (p. 36).
  - *Typically, the rules of deduction are drawn from symbolic logic, in which the rules manipulate symbols without reference to the interpretation or the meaning of the symbols. That is, the manipulations are syntactic, depending only on the arrangement of the symbols. <..>*
  - *This syntactic approach comes close to being a sine qua non for theoretical science. Matters of speculation and interpretation are moved from the argument back to the premise.*

- Not only an ontology concerns, but rather an architectural concept:
  - In business and technology, this is reflected in Modularity Theory, which explains product adoption and market performance, as championed by the Christensen Institute)
  - https://www.christenseninstitute.org/theory/modularity/

KerML – Kernel Modeling Language

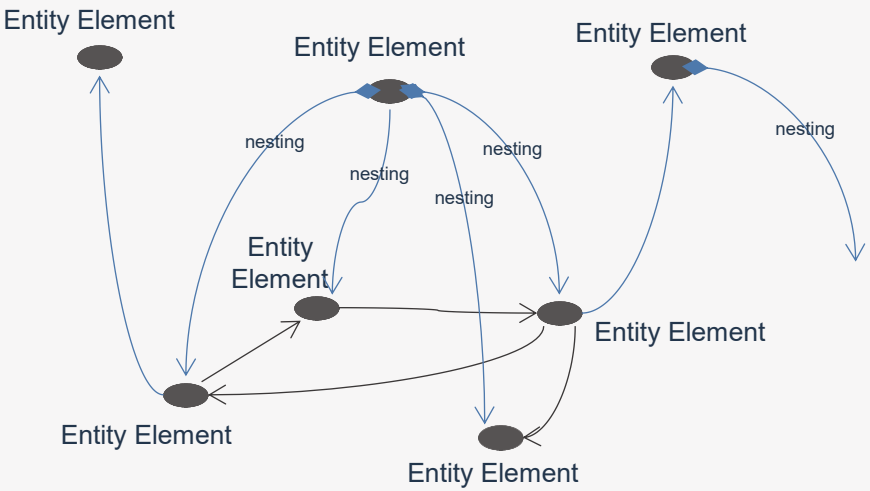
- KerML is a formal, foundational language designed to provide the precise semantics for the OMG Systems Modeling Language (SysML) v2 and other modeling standards. It serves as a minimal, rigorously defined core language that captures essential modeling constructs—such as objects, relationships, types, and behaviors—in a mathematically precise way.
- Key concepts introduced by KerML at the syntax layer:
  - **Feature**: the contextualization of a type within another type
  - **Classifier**: a type that is made of the contextualization of other types.
- Key pending issues:
  - KerML as many other foundational language (including BORO, ISO 15926 and UFO) relies on a non-local theory of relationships: tuples.
  - Graphs also have natively flat relations (edges between nodes).
- While:
  - Languages and models rely on locality/nesting/scoping (functions inside functions, entities inside entities, modules, namespaces).
  - Nextflix initiative relies on “named-graphs” to add locality to RDF.
  - Even LLMs (like programming languages) thrive on scope, hierarchy, and compositionality.

SysFEAT layered approach of relationships

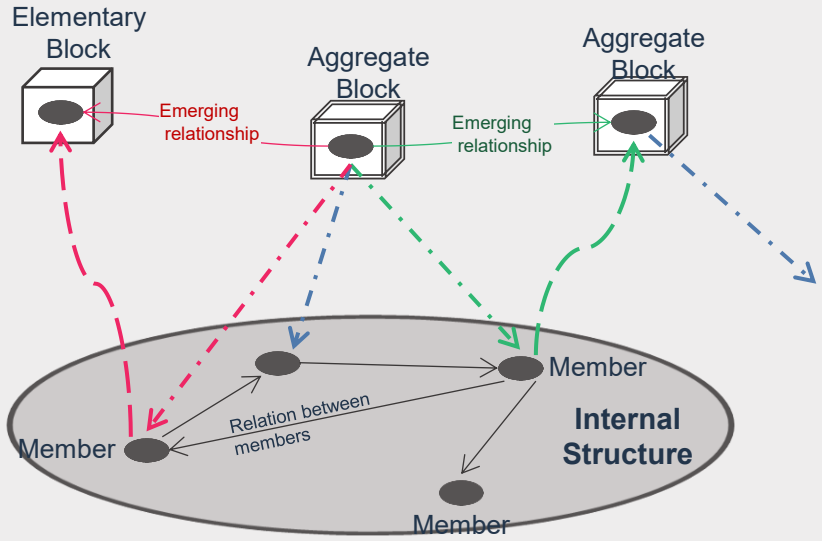
The modularity principles of SysFEAT aims at providing modular connectable structures, using a layered approach of relationships.

1. Locality of relationships is supported by Kuratowski ordered pair, which embeds order and source–target asymmetry inside set theory:
   $\langle a,b \rangle = \{ \{a\}, \{a,b\} \}$
2. Lexical scoping provides the ability to nest entities *(namespace in KerML)*.
3. Compositionality provides dynamic locality for entities *(aggregates in DDD, that and connectors in KerML).*

Elementary Graph



Secondary Graph



Metamodeling, Higher order types and conceptual partitioning

"The major problems in the world are the result of the difference between how nature works and the way people think."

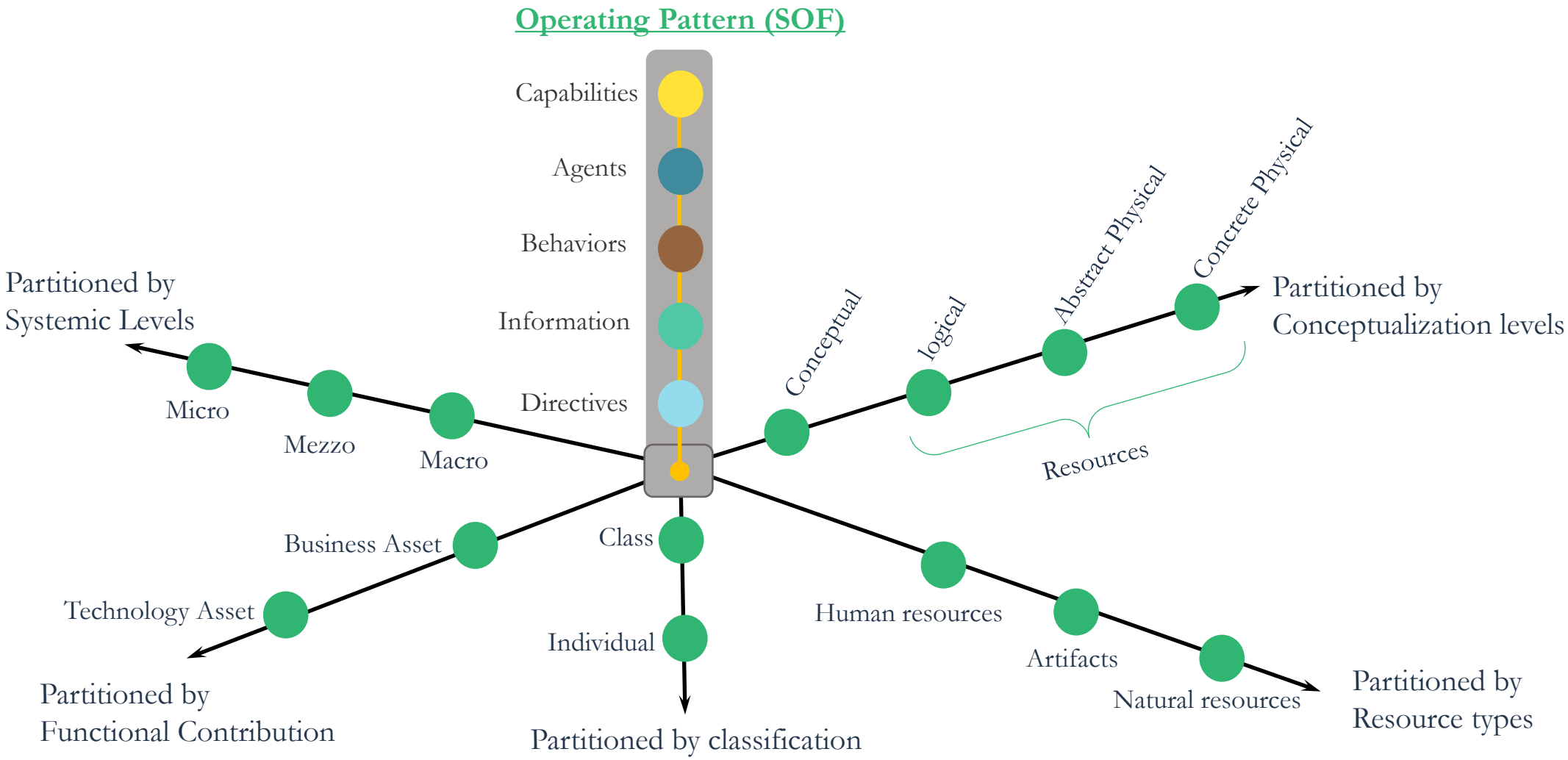
— Gregory Bateson,

Metamodeling foundations.

- **Multi-level stratification**: the word is higher-ordered (UFO is adopting it through its MLT initiative).
- **Power-types as meta-classes**: it gives the foundation for a layered classification of higher order types (Cyc has MLT meta-classes but they are not power-typed based).
- **Meta-circularity**: need for self-referential meta-classes, that live at higher levels but can instantiate themselves
  - This avoids artificial separation between meta-class levels. The system can represent and reason about itself.
- **Meta-Patterns**: need to group classes in family of classespartitions class hierarchies in

- SysFEAT combines and extend ISO-15926, MLT, BORO and Cyc approaches by:
  - Grounding multi-level classification on power-types (MLT and BORO).
  - Adding meta-circularity (Cyc), based on non-well founded set theory (Mattthew West and Stanford Encyclopedia of Philosophy) and power-types.
  - Organizing conceptualization patterns as set theory partitions.

The SOF as an example of partition based conceptual patterns



4D, Time and semantics

"He who has been can no longer not have been: henceforth this mysterious and profoundly obscure fact of having lived is his viaticum for eternity"

Vladimir Jankélévitch, L'Irréversible et la Nostalgie.

Matthew West – ISO 15926 - BORO

- 4-dimensional foundation (Matthew West)
  - 4-dimensional spatio-temporal extents with extensional identity,
  - Dissective and non-dissective classes,
  - 4-Dimensional Patterns,
    - Mereology and replaceable parts,
    - Levels of reality for what things are constituted from,
    - Activities and events,
    - Roles as temporal parts of individuals,
    - Relationships as states with states of individuals as parts,
    - Possible Worlds for dealing with plans,
  - Classes as sets, since membership does not change,
  - Properties of various sorts including physical quantities

- SysFEAT integrate the 4D the above foundations while integrating them with KerML and the pattern of Compositionality.
  - Event as behavior boundaries.
  - Interaction behaviors as boundaries of agents.
  - Contextual properties to qualify internal parts.
  - Inheritance from dynamic locality (an aspect of compositionality).

Undergoing work to map with UFO (properties and identity)

- Matthew West (about properties)
  - On the other hand, the traditional idea of a property, with the notable exception of temporal properties, would seem to correspond closely to temporally dissective sets of individuals.
  - Thus properties are inherited by states of the spatio-temporal extent to which they apply (although it is not only individuals that can have properties).

- Mathew West (this is about UFO Kind):
  - It is interesting to note that temporally non-dissective sets correspond closely to the traditional idea of natural kinds, and can perhaps be thought to usefully be the 4-dimensional definition of a natural kind. (Ontology Meet business)

Causality and Human Factors

It cannot be stressed enough that the indiscriminate application of engineering concepts to biological situations is fraught with danger.

Russell Ackoff

Enterprise Economics

Automatically attributing to individuals a universal will to maximize their personal gain is not a liberal principle, despite claims to the contrary. The foundation of a free society is that every person—natural or legal—must take full responsibility for their self-determined goals, knowing that the initial creators of economic wealth, are individuals.