http://www.travelstart.co.za/blog/wp-content/uploads/2013/11/Greg-Lumley.jpg

Designing an Effective Graphical Modelling Language

in Information Systems and Enterprise Modeling

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Contribution to April Colloquim
Raitenhaslach, Bavaria
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inspired.org

Outline

Domain of Interest / Research Problem

Stakeholders, Concerns, Goals

Purposes of Modelling

Scope, Orientation, Situation

Modeling Meaning

Communication

Graphical Modelling

Problems

Opportunities

Design

Bigger Issues

Relevance of Research

Organisations are undergoing massive transformative change due to shifts in politics, economy, technology, society, legislation

Business and Society increasingly dependent upon systems and their automation and integration. Evidence: Commercial Information Systems, Digital Transformation, Embedded Systems, IOT, Social Media, Convergence, Machine Learning, Big Data, Analytics, Personal Medicine etc.

Modelling can improve the understanding of current situations, problem solving, design of solutions and decision making as to alternatives and priorities

A huge amount of effort expended on modeling but possible benefits not always achieved. Many reasons, but one which we choose to focus on is the choice of, design of and efficacy of visual languages/ graphical models used in enterprise transformation and information systems

The goal is to improve the return on modeling effort (ROME) by improving ease of use, understanding of models, insights gained and efficiency of usage

A sub-goal is to provide insights into the support required in meta models and tools to achieve the primary goal

The Research Problem

Visual Languages (Concrete Syntax) in Enterprise Modeling and Information Systems are often poorly designed

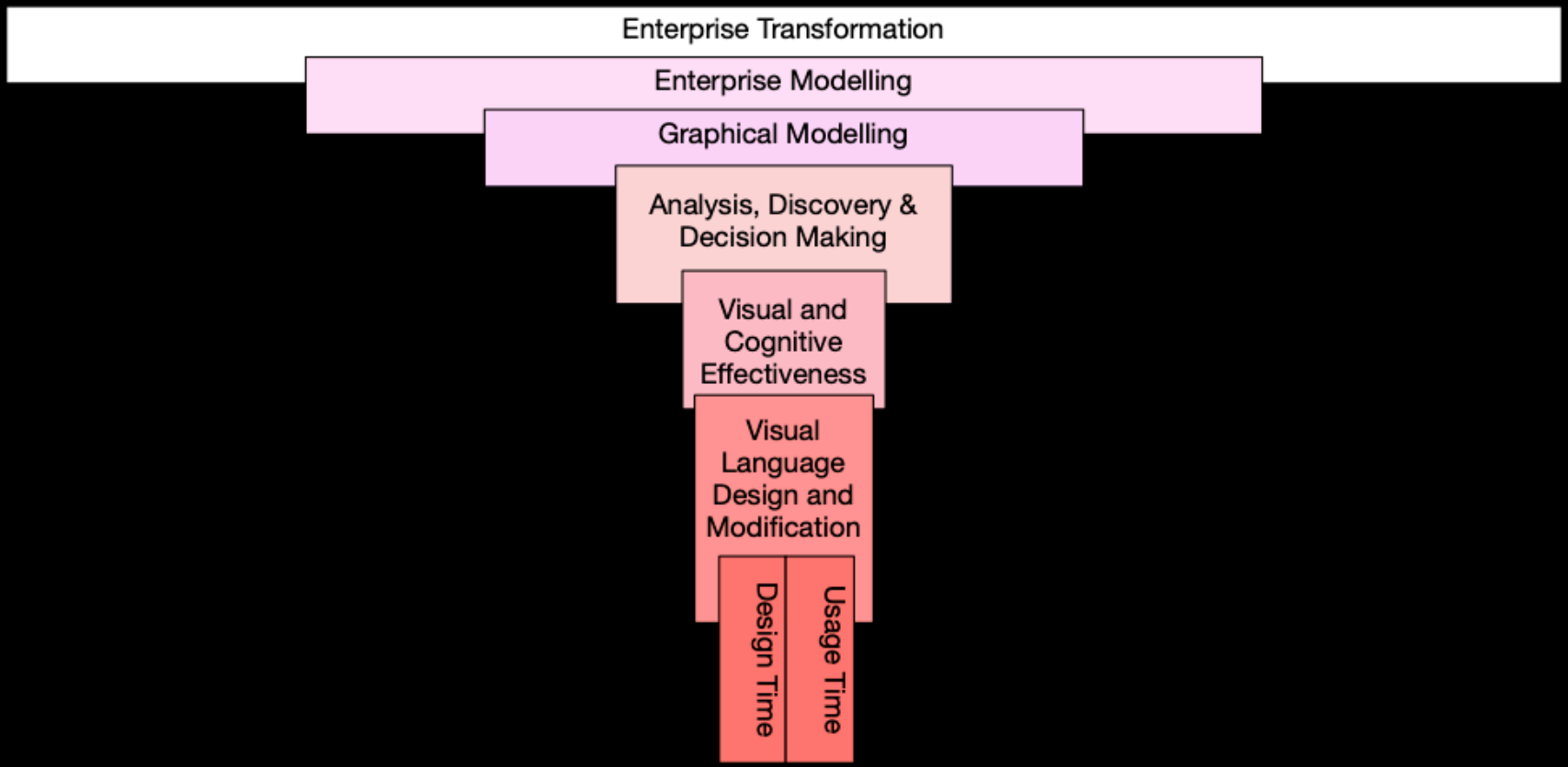
- Arbitrary symbols are chosen without good rationale e.g. UML, Archimate
- Notations can be overwhelming, intelligible only to experts with extensive training e.g. BPMN, DEMO
- Human cognitive capabilities are not well exploited. Not considered / not using latest research
- Models often become large and hide important information e.g. BAIN, ERP Data Models, Application Landscapes

Opportunities for enhancing comprehension, insight and decision making are lost

How can we

- Design better visual languages?
- Reduce effort in creation and subsequent use of models?
- Modify the languages at usage time to improve insights and decision making?
- Better exploit the capabilities and overcome limitations of the human visual /cognitive system?

Situating Research



Effectiveness

Defining:

The extent to which models help Stakeholders achieve their purpose with minimum effort and delay

Achieving

- Address Domain Concepts
- Address Stakeholder Needs/Background/ Questions/Intent
- Capture Knowledge
- Support Analysis
- Communicate / Convince
- Tool Support
- Community Acceptance

Who?

Image: 123rf//gmast3r

First we need to know who the Stakeholders are

Who has the essential information?

Who will author the models?

Who will review and analyse the models?

Who will approve and publish the models?

Who should be persuaded by the models?

Stakeholder Management Techniques

Freeman, R. E. 1984. Strategic management: A stakeholder approach. Boston: Pitman

Stakeholders and Concerns

Programme Manager

Accountant

DBA

Sales Manager

And then we need to meet their needs

- What is their orientation?
- What are they familiar with?
- What is their level of literacy wrt models / notation format?
- What are their concerns?

Domains

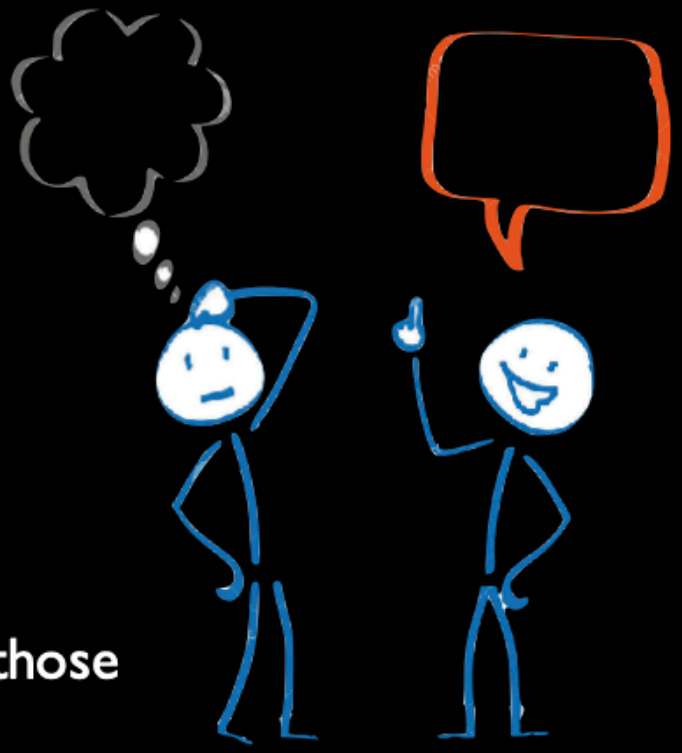
Represent areas of (specialised) knowledge

e.g. Healthcare, Education, Retail, Banking, Manufacturing, Astronomy

They have special vocabularies e.g. Patient, Prescription, Treatment, Formulary etc.

Can enhance speed and accuracy of communication for those in the know

But can be a barrier for those who don't know the language



Why

image source: bbc.co.uk

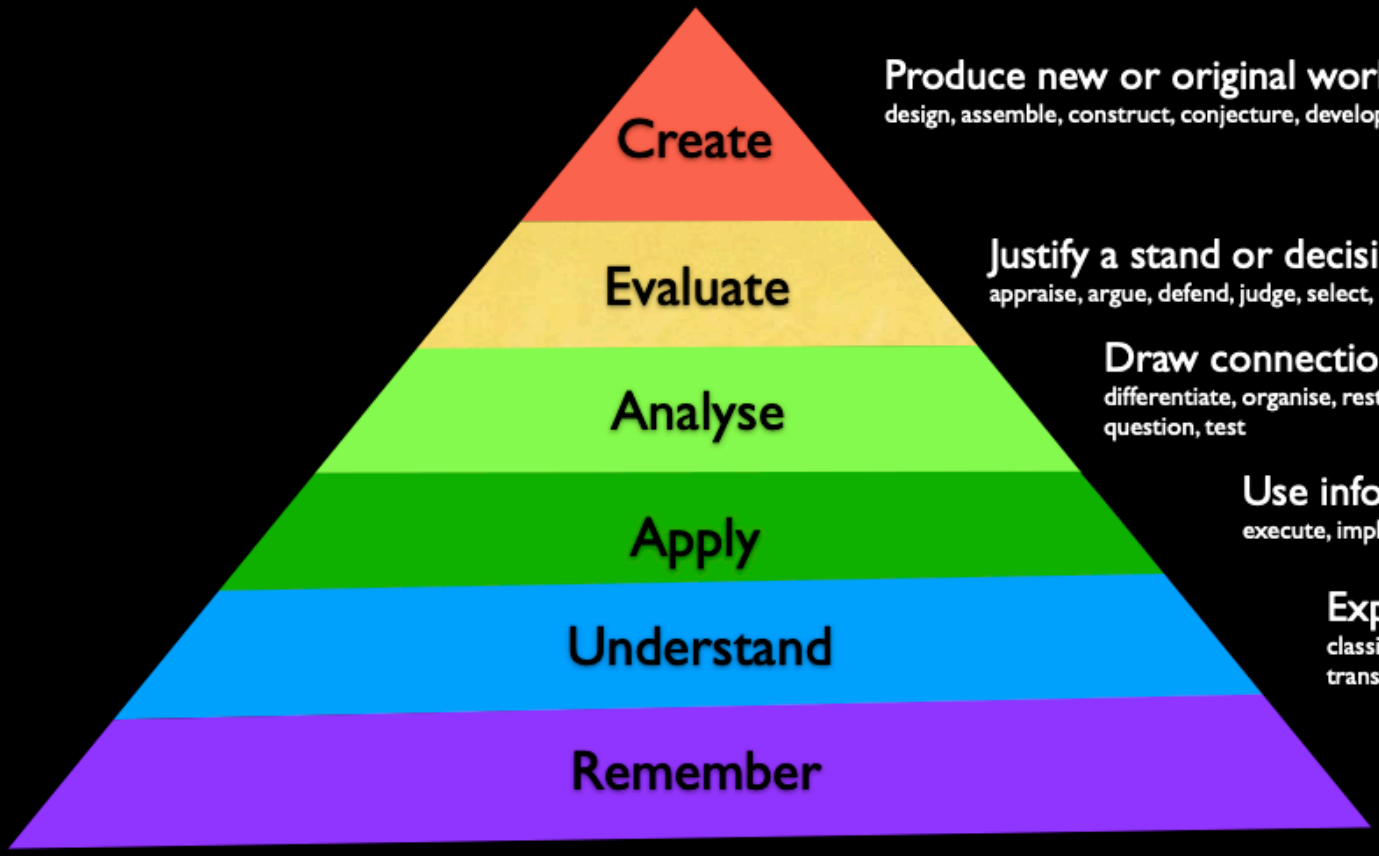
What is the purpose of the models?

What decisions should they support?

What insights do we wish to obtain?

What should they achieve?

Bloom's Taxonomy



Produce new or original work
design, assemble, construct, conjecture, develop, formulate, investigate

Justify a stand or decision
appraise, argue, defend, judge, select, support, value, critique, weigh

Draw connections among ideas
differentiate, organise, restate, compare, contrast, distinguish, examine, experiment, question, test

Use information in new situations
execute, implement, solve, use, demonstrate, interpret, operate, schedule, sketch

Explain ideas or concepts
classify, describe, discuss, explaoin, identify, locate, recognise, report, select, translate

Recall facts and basic concepts
defne, duplicate, list, memorise, repeat, state

Clark, Donald R. (1999). "Bloom's Taxonomy of Learning Domains". Retrieved 28 Jan 2014.

Models as Language

Language is uniquely Human

Some say language is what *makes* us human

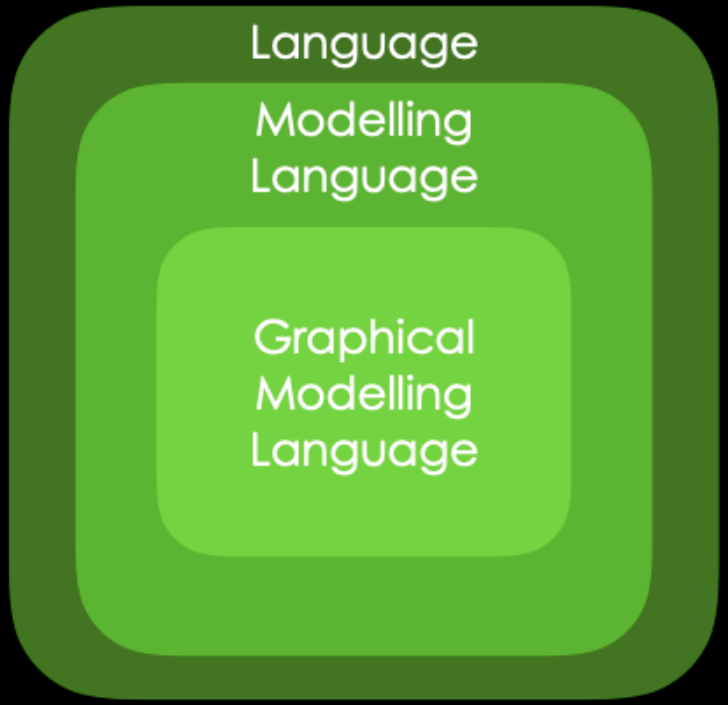
It is what allows us to communicate effectively and share goals, thoughts, feelings, ideas, designs…

Language can be spoken, written and drawn

Models represent a powerful kind of language

From Physics of Notation to Grammar of Models

Language



A way to communicate between parties

A way to communicate precisely between parties using an agreed vocabulary and grammar

A way to communicate precisely between parties using visual symbols, connectors, containers and their arrangement following an agreed notation, representation and (potentially) layout

Language

Has nouns to communicate about objects and ideas

Adjectives to describe the nature of objects and ideas

Verbs to convey action

Adverbs to modify the action in some way

Proper names and pronouns to identify actors

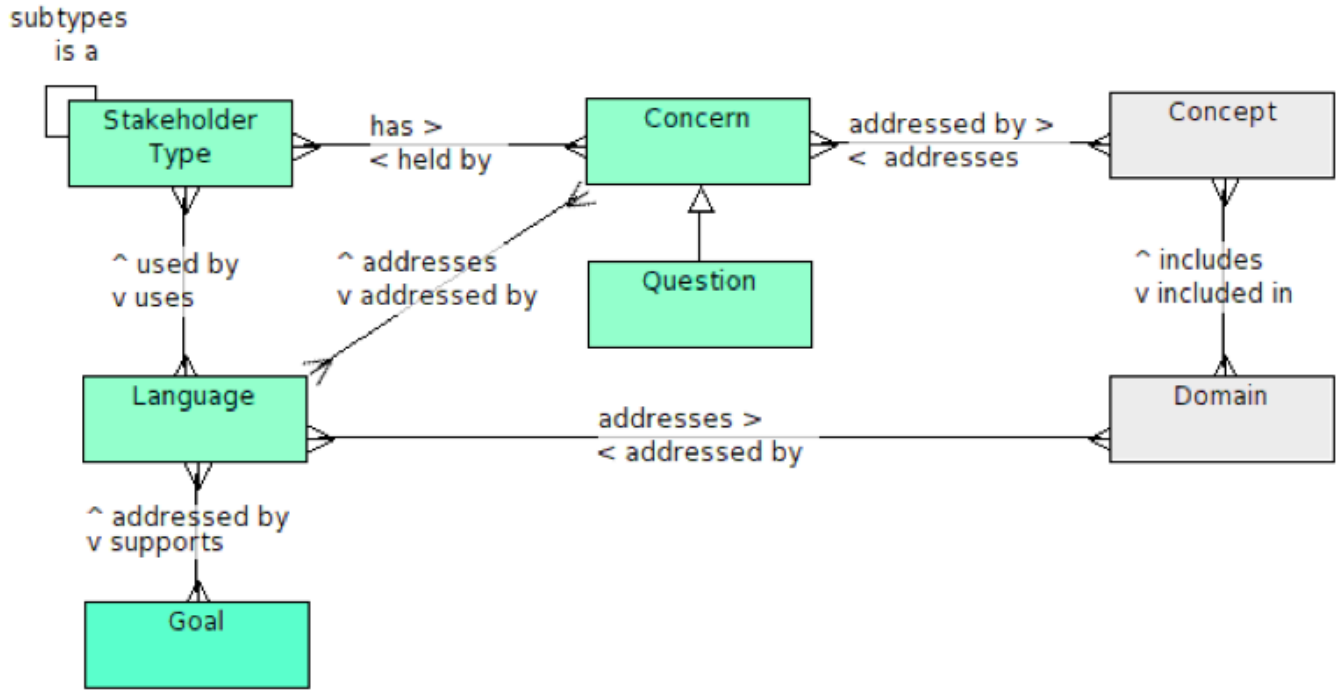
Connectors to join ideas together

Structure to help users communicate more easily (encoding and parsing)

Punctuation to group, separate and clarify

Image Credit: Cherry Mathew Philipose

User / Language / Purpose



Communication Model

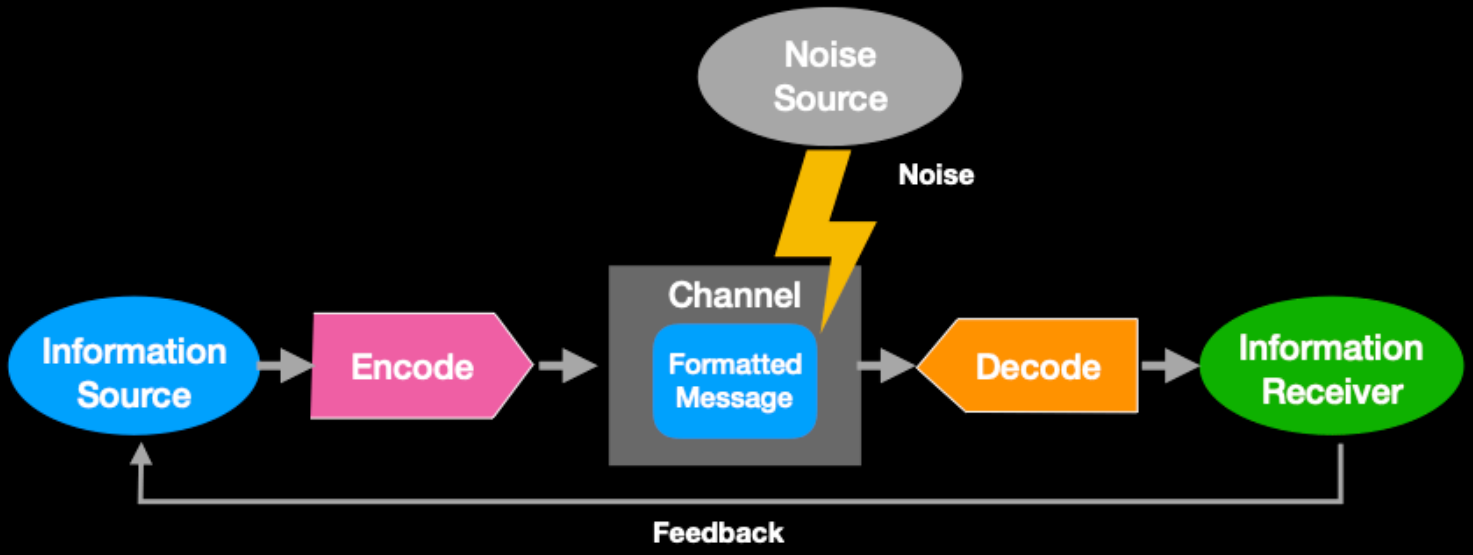
Claude Shannon & Warren Weaver, 1949

Entropy

Redundancy

Noise

Channel Capacity/Bandwidth



What

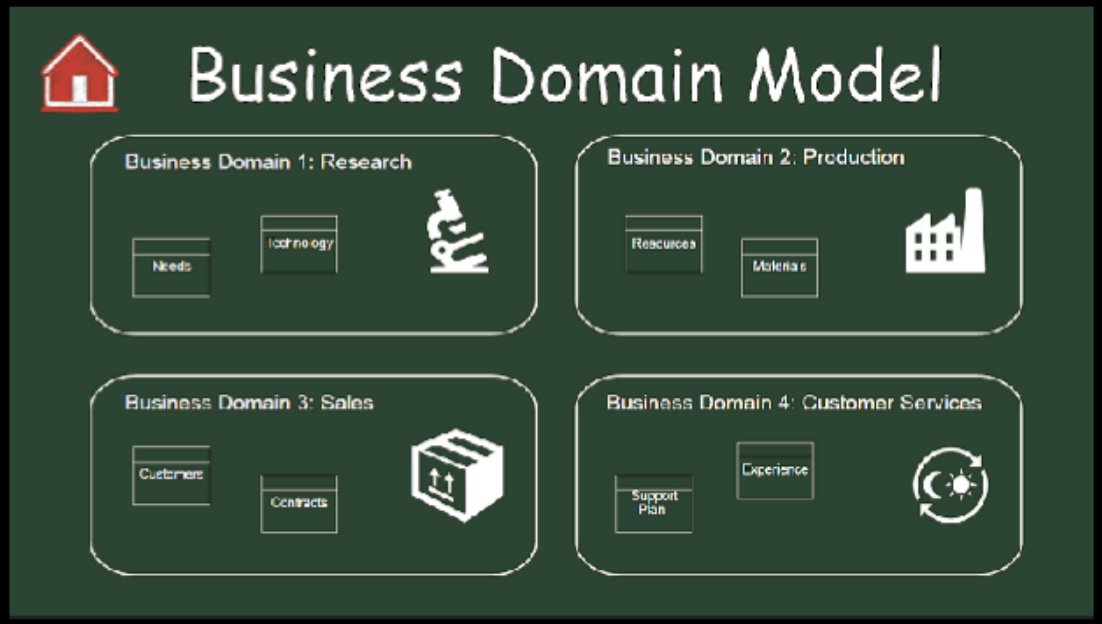


image source: dragon1.com

What is the domain of interest?

What are the relevant concepts?

How standard are they?

Are there already well accepted models and/or notations?

What questions do we want to answer?

When

Under what conditions will the models be produced?

What constraints are there on time, resources, location, participation, tooling etc.?

How will the models be updated and how much of a requirement is this?

How current must the information be?

Are the models supporting future: Strategy, Architecture, Design?

image source: elpais.com

How

image source: blogsnow.com

Who has the information?

What form is it in?

What is the most effective way to gather it?

How should it be stored, shared, secured?

How should it be analysed, reported, represented, queried?

What notation(s) is(are) appropriate?

What skills are required of the modellers?

Defining Semantics of Domain

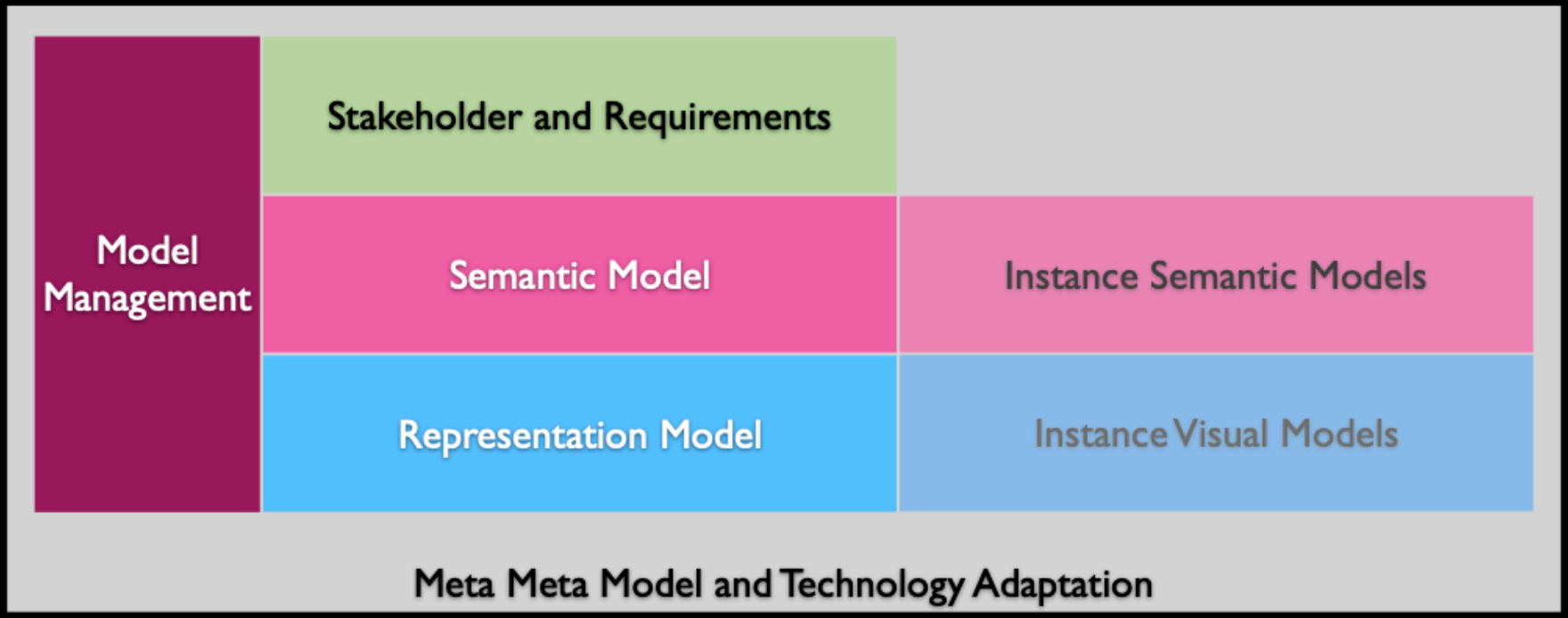
We need a semantic layer to express the concepts, properties, relationships, constraints and knowledge of the domain

In a way that captures meaning independent of language, tools and representation

This is essentially a rich data model schema

Hence a competent meta model or semantic model (e.g. OWL) is appropriate

Meta Model Components



Combining Domains / Languages

Domains and languages may have overlapping concepts e.g.

- Process Models will mention data that is referenced, recorded or updated
- Goal Models are tied to Organisation Units that are responsible for their achievement
- Capabilities are linked to Applications which support their achievement

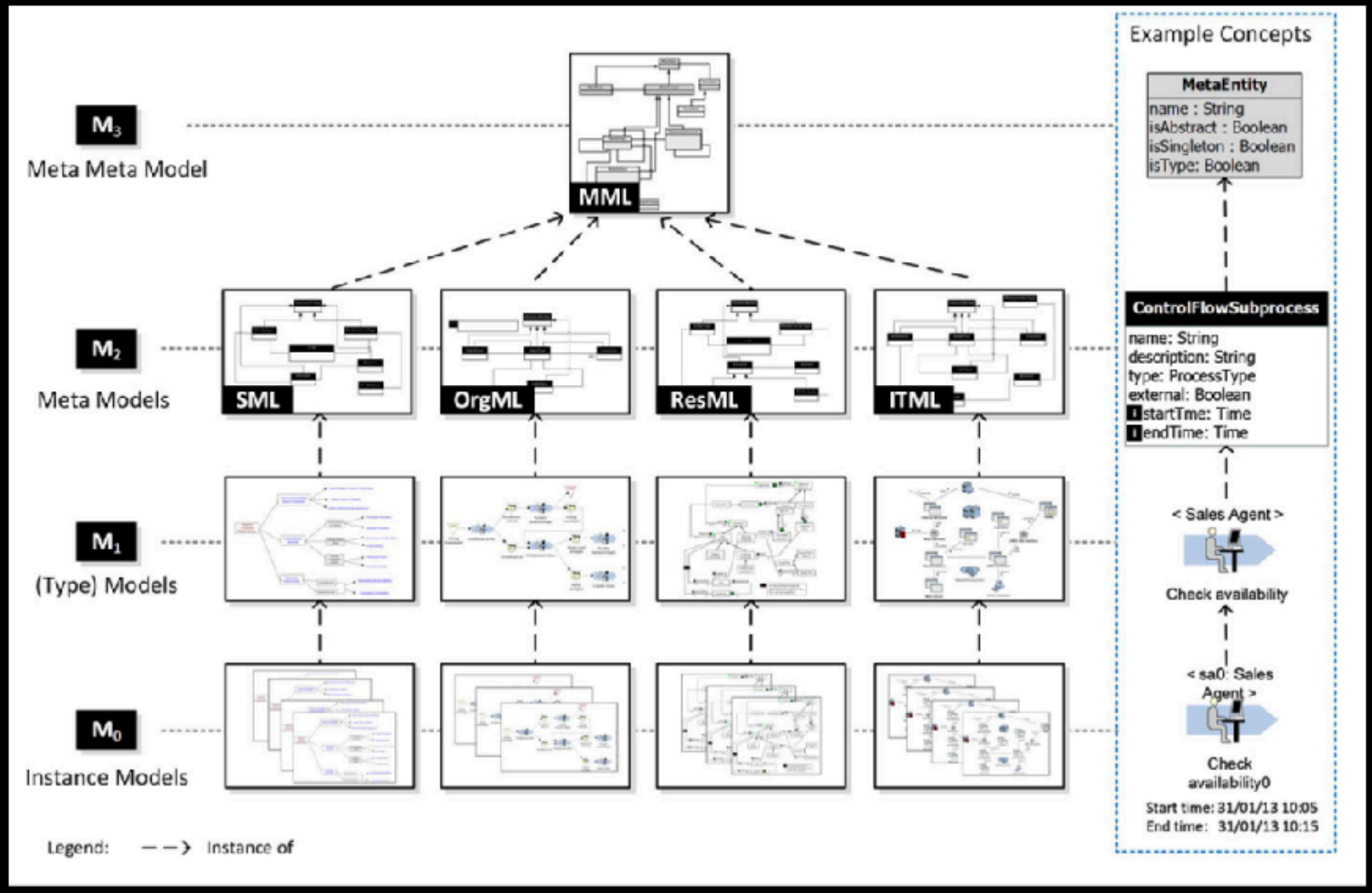
We want a properly resolved semantics that allows sharing data where relevant and using concepts and naming consistently across communities

We thus want a single, extensible meta model that can evolve with new requirements and language requirements

We also need the ability to retain naming from imported models / stakeholder community, hence aliases

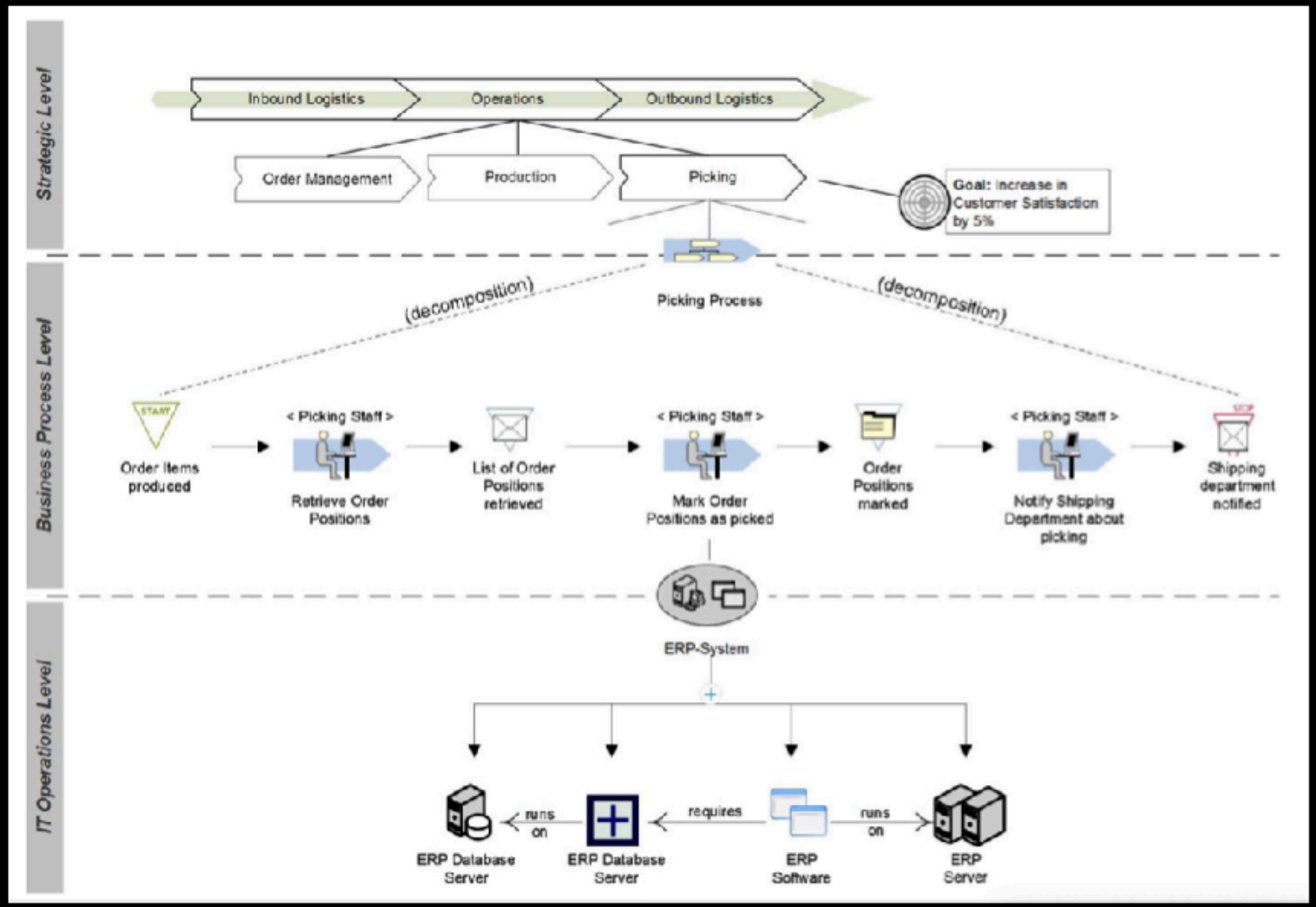
MEMO Language Architecture

Ulrich Frank and colleagues Univ Duisburg-Essen

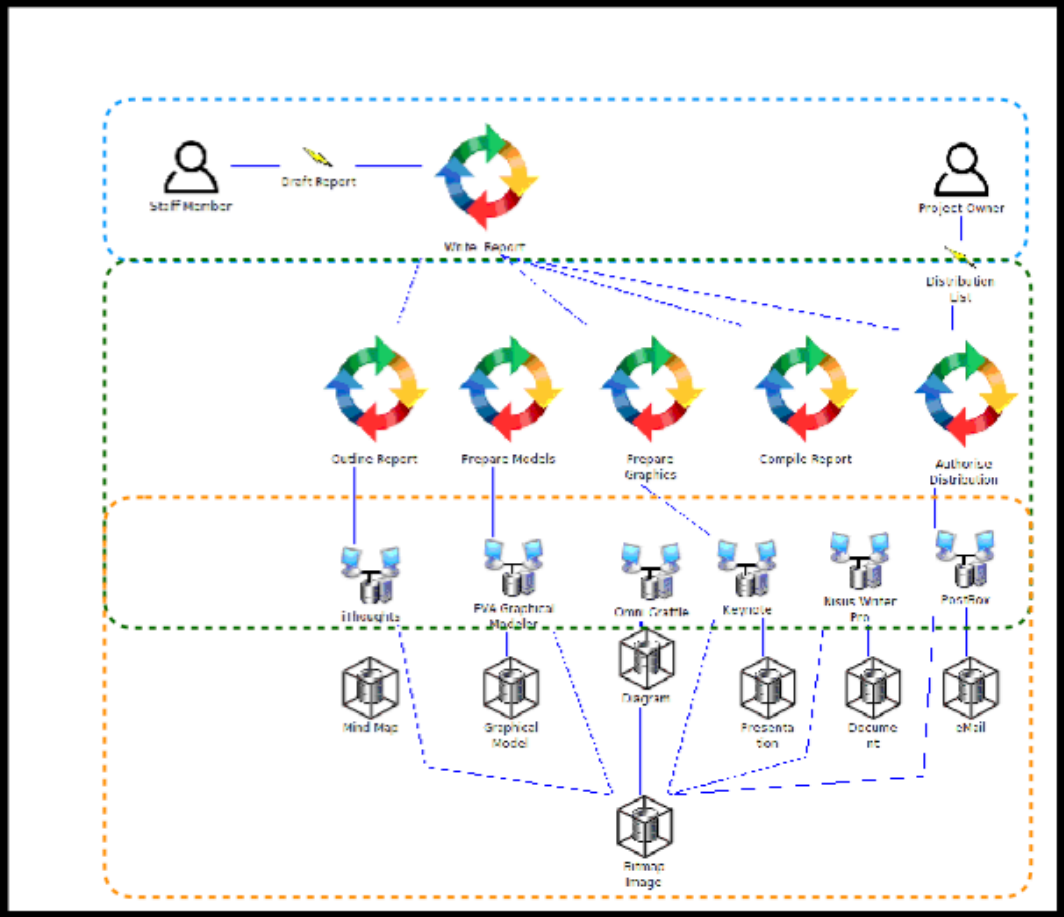


Multiple Perspectives and Layers in MEMO

Ulrich Frank and colleagues Univ Duisburg-Essen



Multiple Overlapping Perspectives

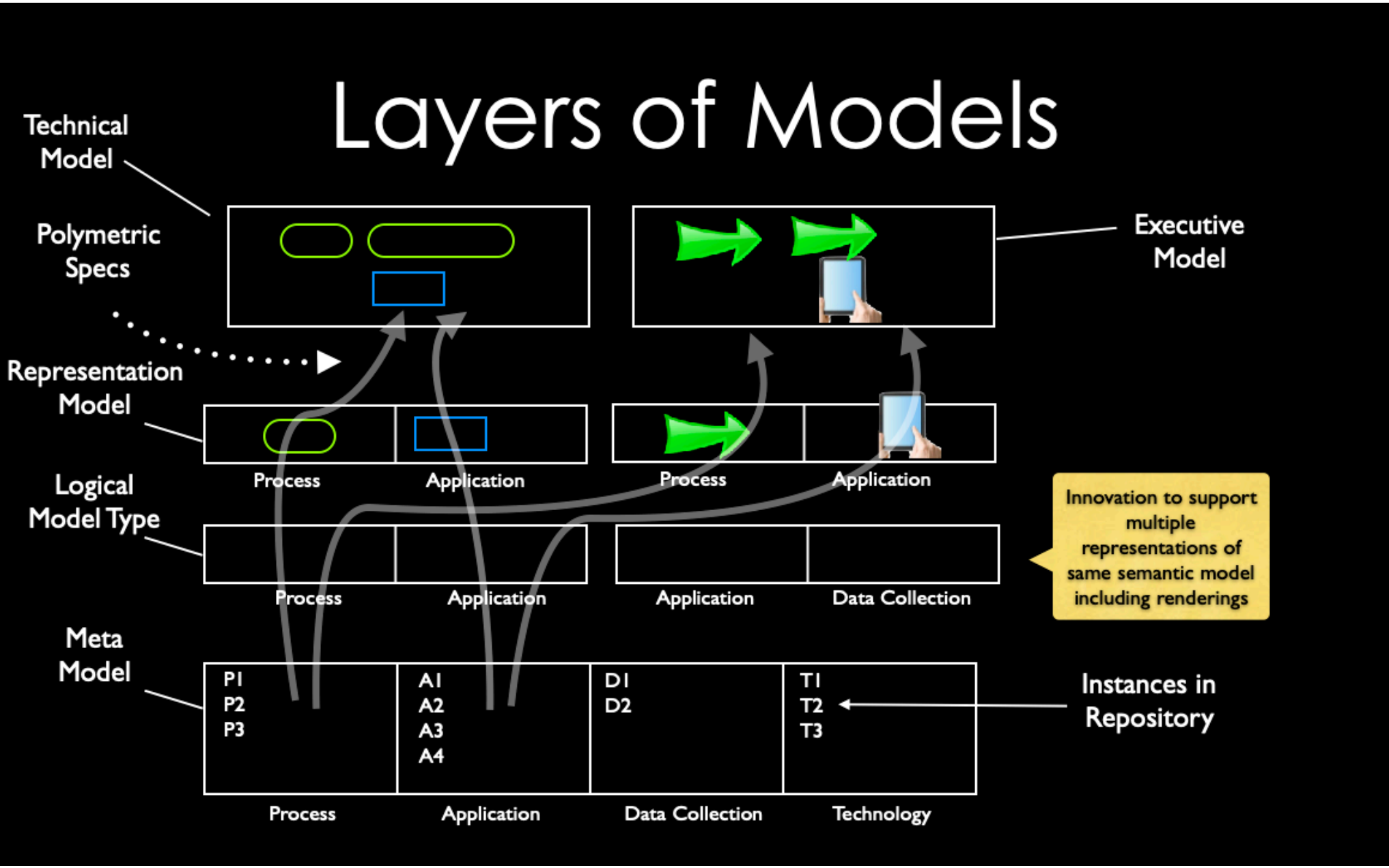


Strategic View

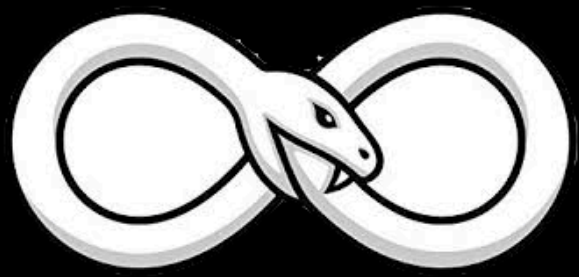
Process View

Application View

EVA Graphical Modeller Tool - inspired.org


Layers of Models
Technical Model
Polymetric Specs
Representation Model
Logical Model Type
Meta Model
Executive Model
Process
Application
Process
Application
Process
Application
Application
Data Collection
P1
P2
P3
A1
A2
A3
A4
D1
D2
T1
T2
T3
Process
Application
Data Collection
Technology
Innovation to support multiple representations of same semantic model including renderings
Instances in Repository

Meta Meta Model



Competent technique required to define the Meta Models for the various visual languages

Requires definition of semantics as well as the visual aspects of the language and the mapping between these

Approaches which seem inadequate: UML/MOF, ECore, Eclipse GMF

Approaches which are competent: MEMO MML; Clark(Meta Circular Kernel - used in XModeler); EVA/Inspired; MetaEdit+; Smalltalk plus enhancements

antic Meta Model

Show Alias

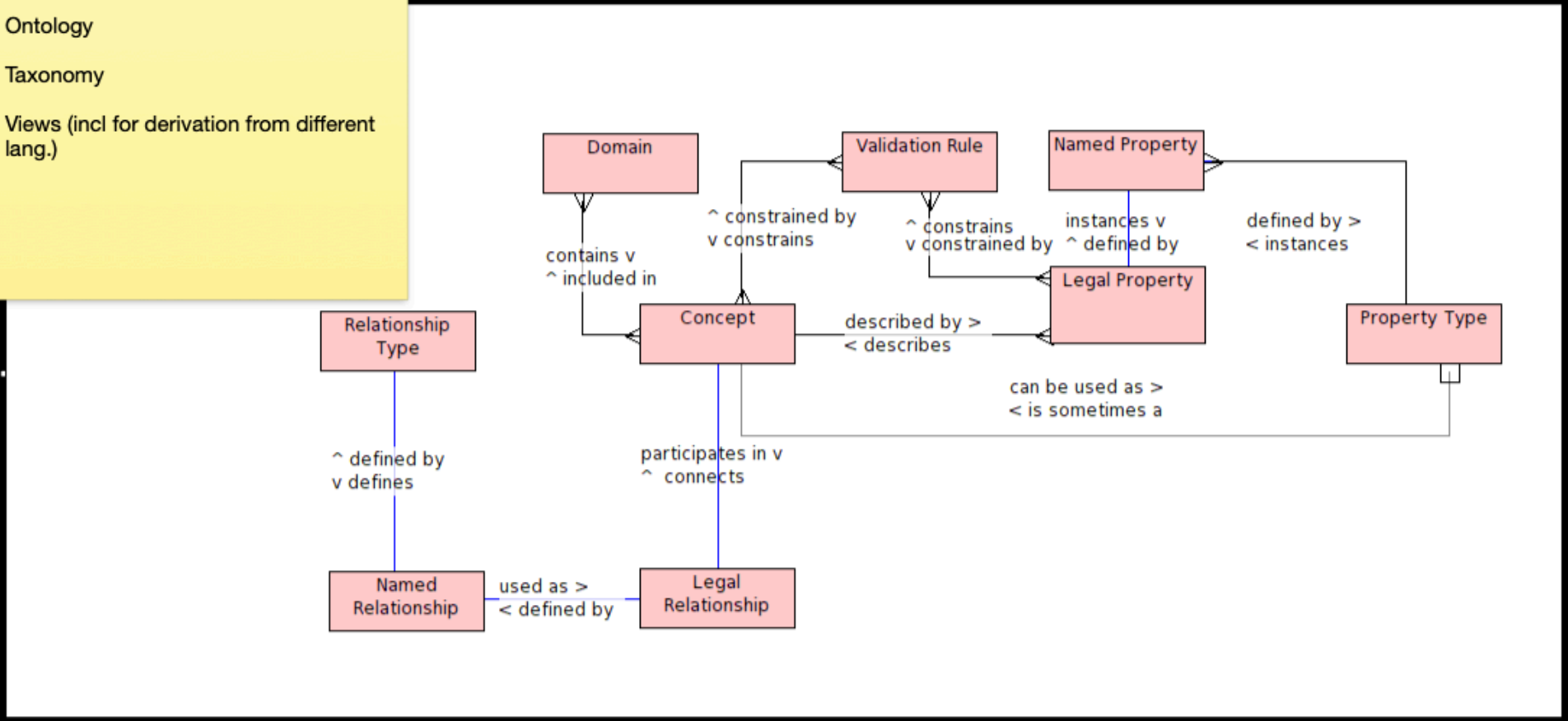
Relationship Types
Property Types

Generalise named thing

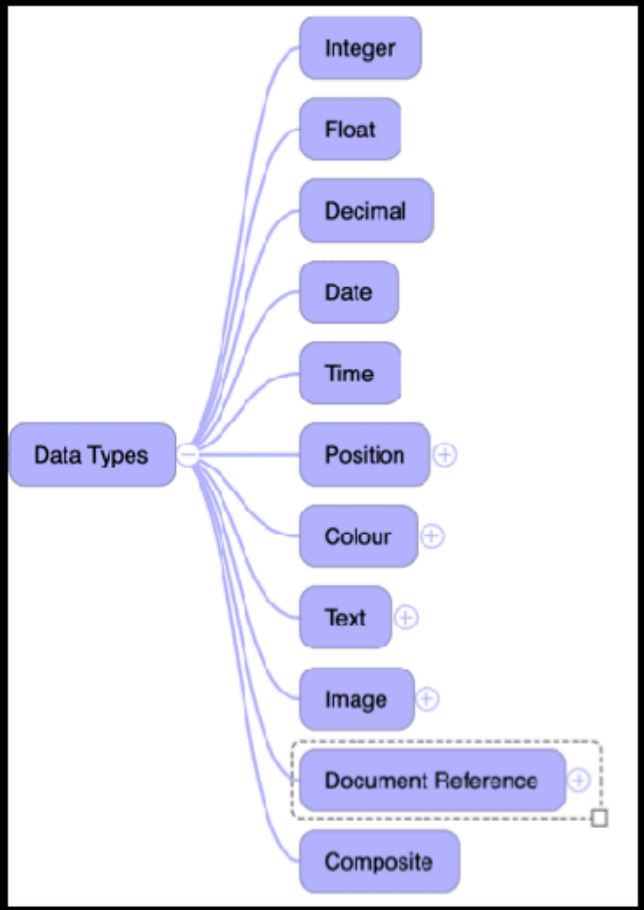
Ontology

Taxonomy

Views (incl for derivation from different lang.)



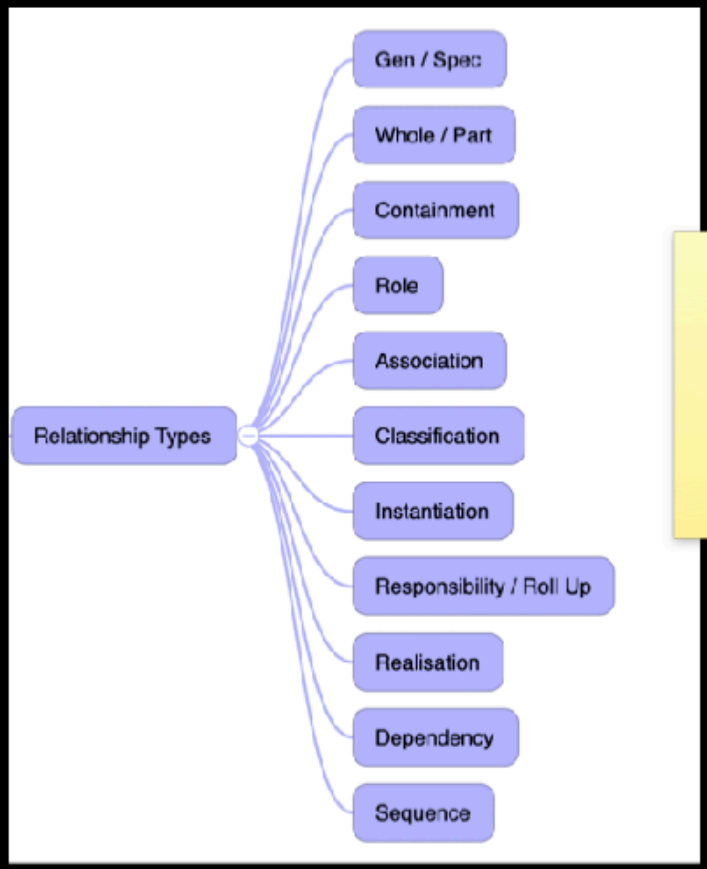
Rich Data Types



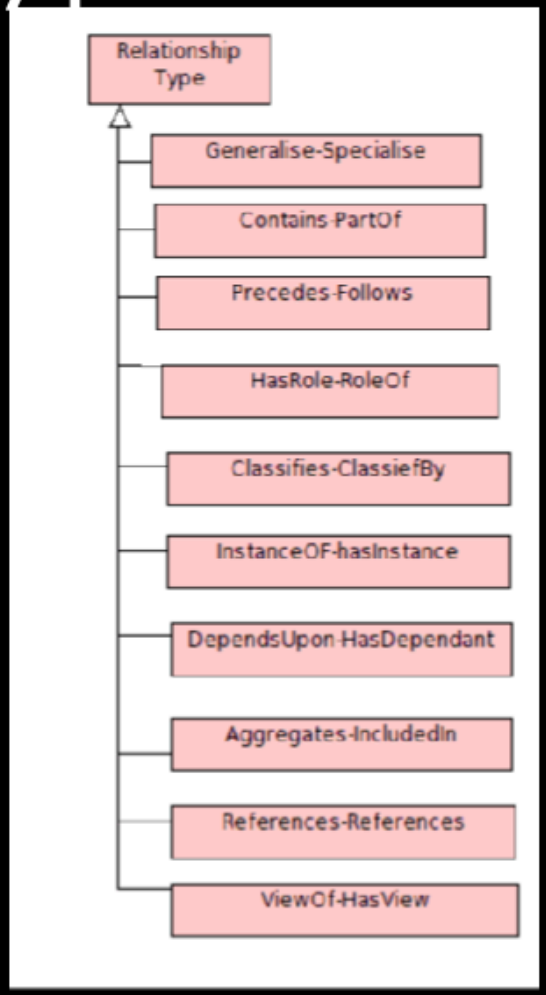
We have found these very powerful in the current EVA Netmodeler tooling

Essentially we implement a base environment (Smalltalk Class) with a predefined protocol and associated interface widgets for composing user interfaces

Relationship Types



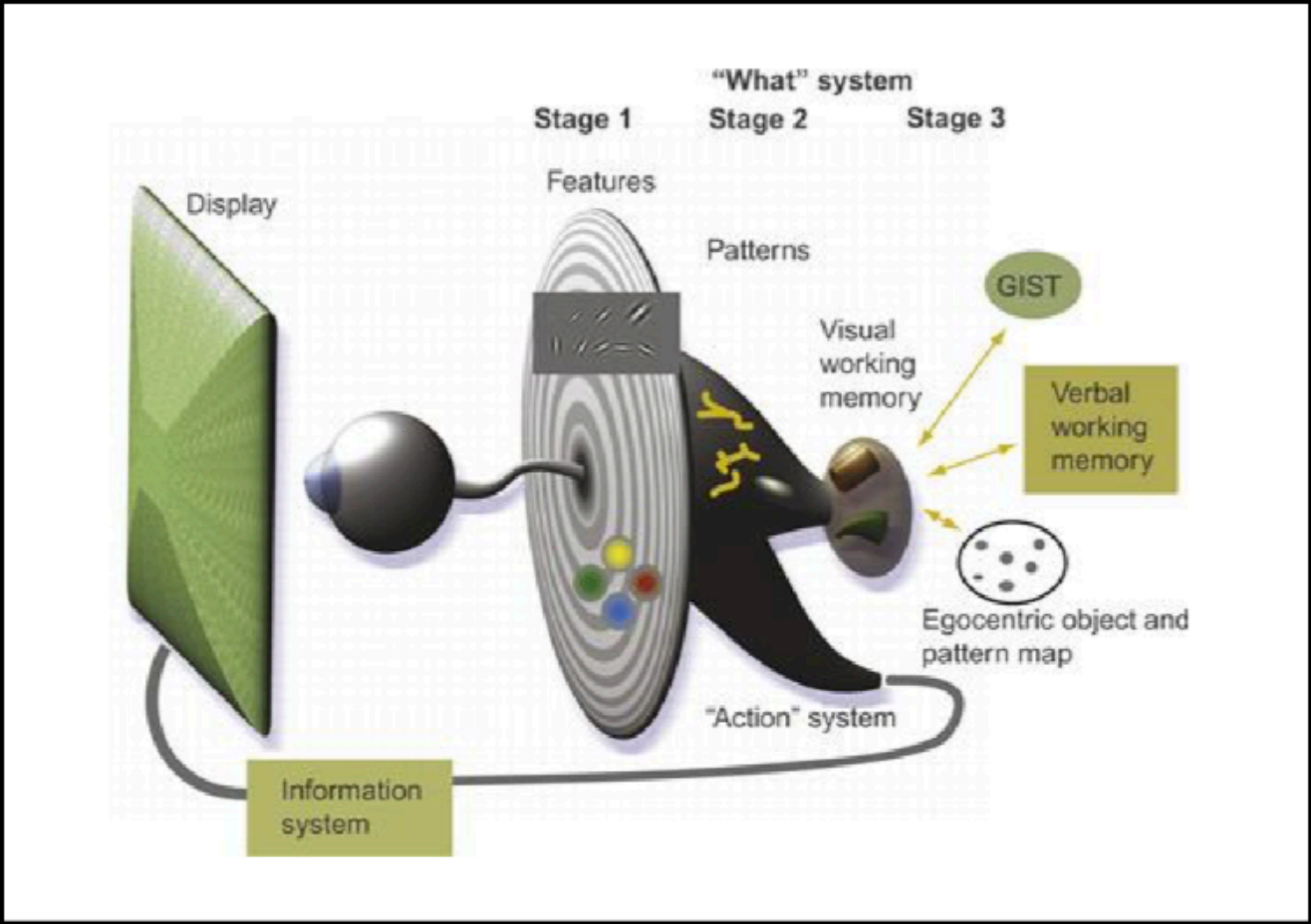
Unspecified



Designing Notation

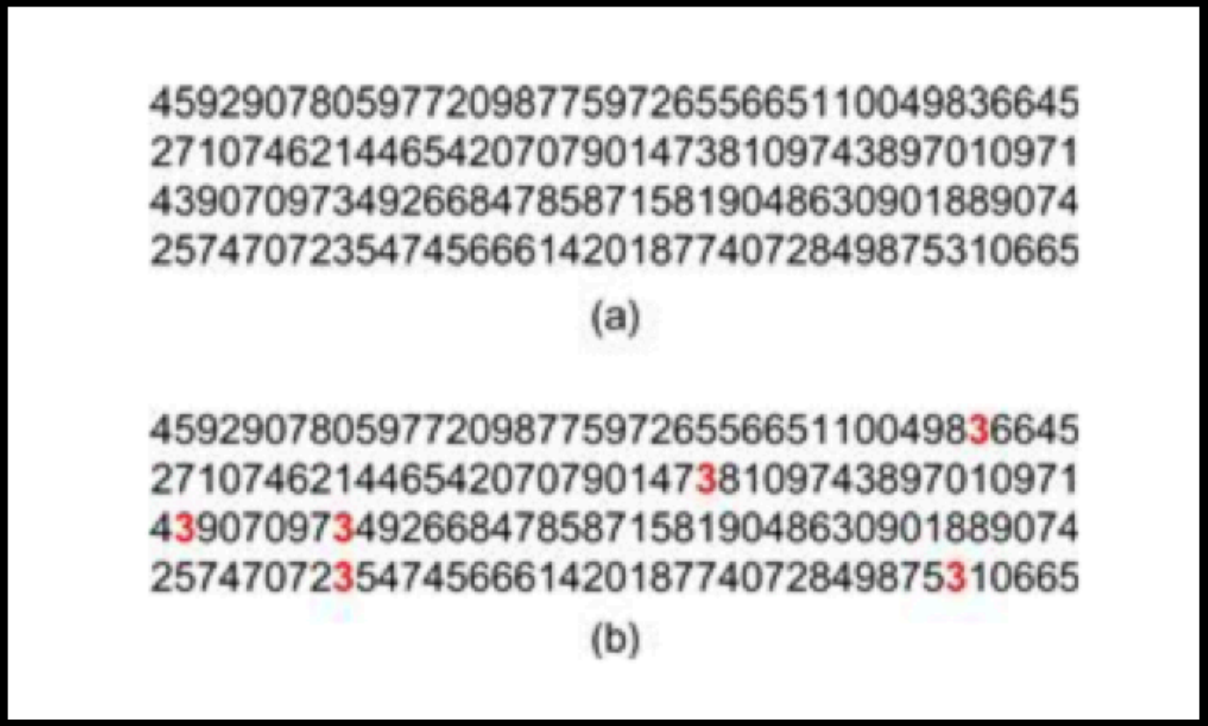
Things to Avoid / Overcome	Things to Achieve / Exploit
Poor Communication	Leverage Human Capabilities
Overloading Model Reader	Facilitate Tool Support
Ambiguity	Clarity / Accuracy
Wasted Effort	Efficiency

Physiology of Human Vision System

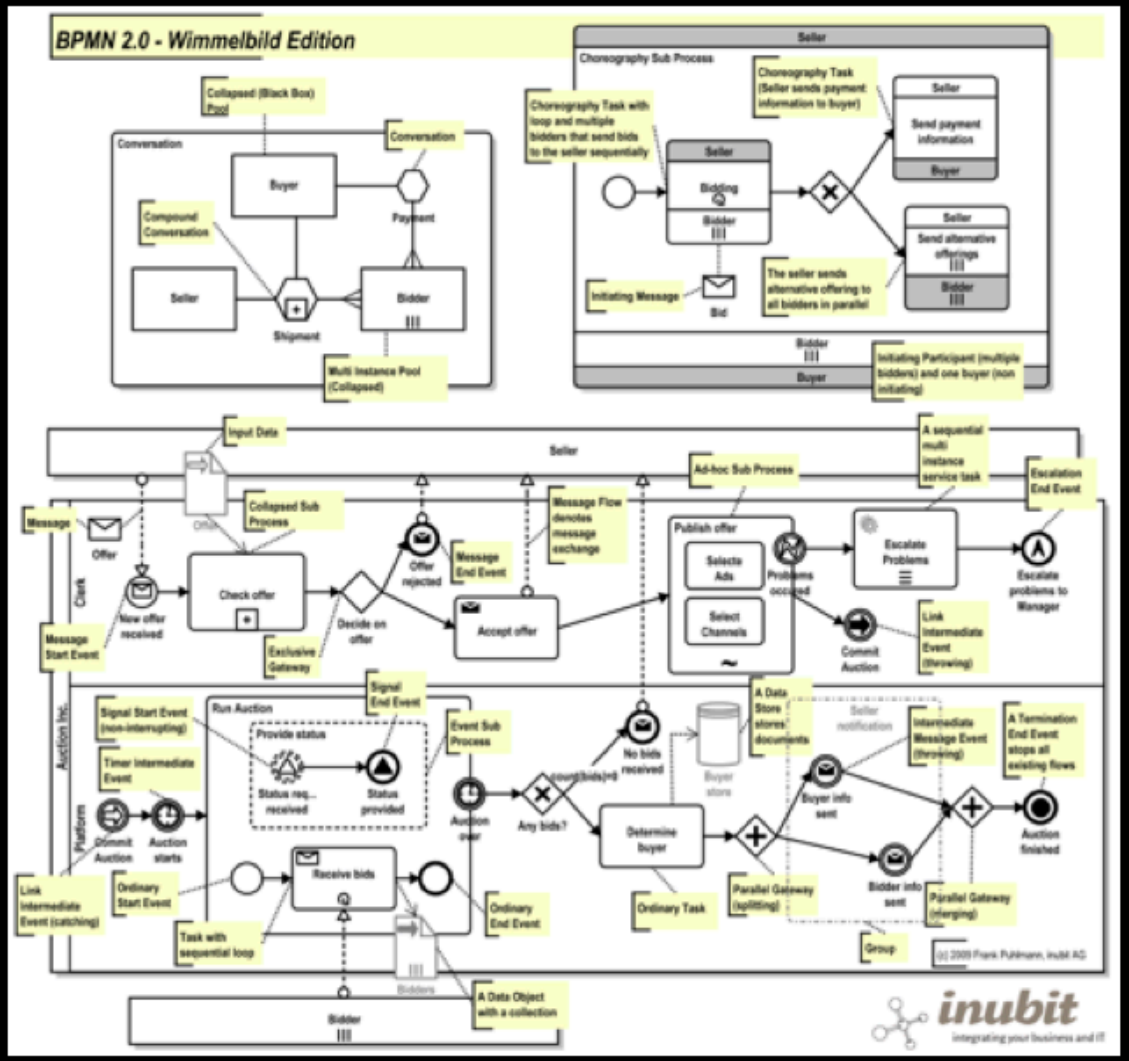


Three-stage model of visual information processing - Ware, 2013

Pre-Attentive Processing



Pre-attentive processing illustration - {Ware, 2013



BPMN 2.0 "Wimmelbild"

by Frank Puhlmann frapu.de

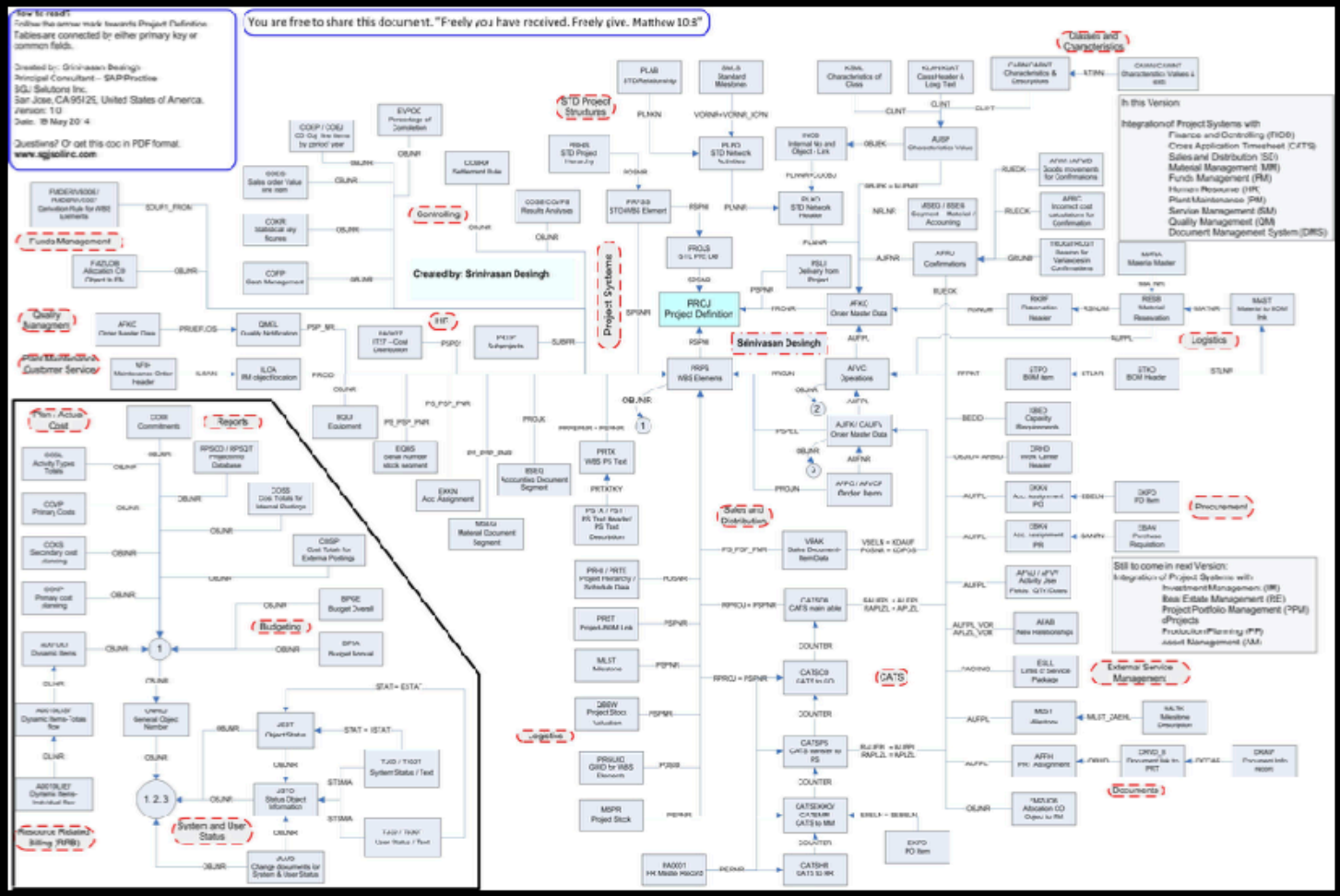
although this one is produced tongue in cheek, it does illustrate the problem for non-experts!

A “Camouflage” Model

and its just a fragment…

Part of the SAP Project Module

https://www.abap-tutorials.com/2014/09/08/sap-ps-module-tables/



Polymetric Examples in SW Eng.

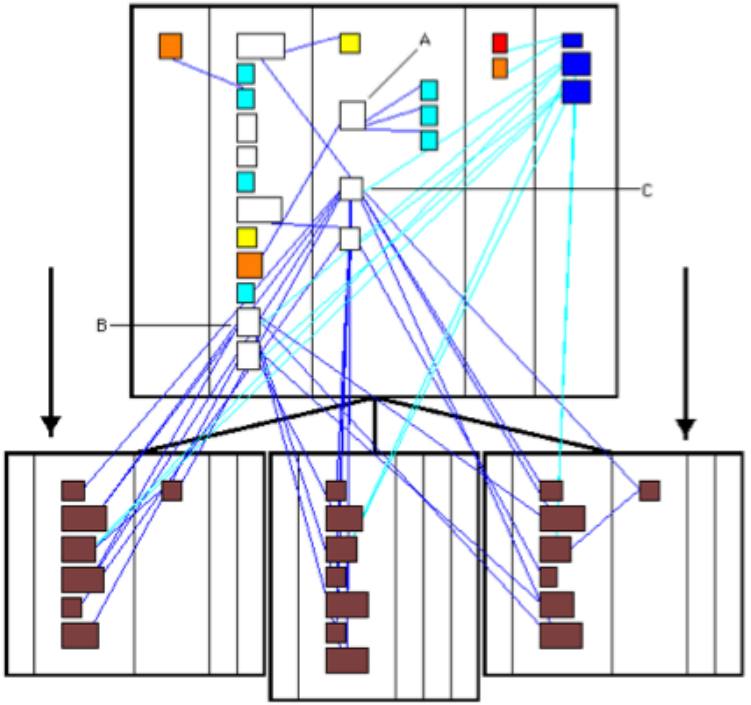


Figure 5.21: A class blueprint visualization of an inheritance hierarchy with the class *JunColorChoice* as root class. Each subclass contains a pure *Siamese Twin* pattern.

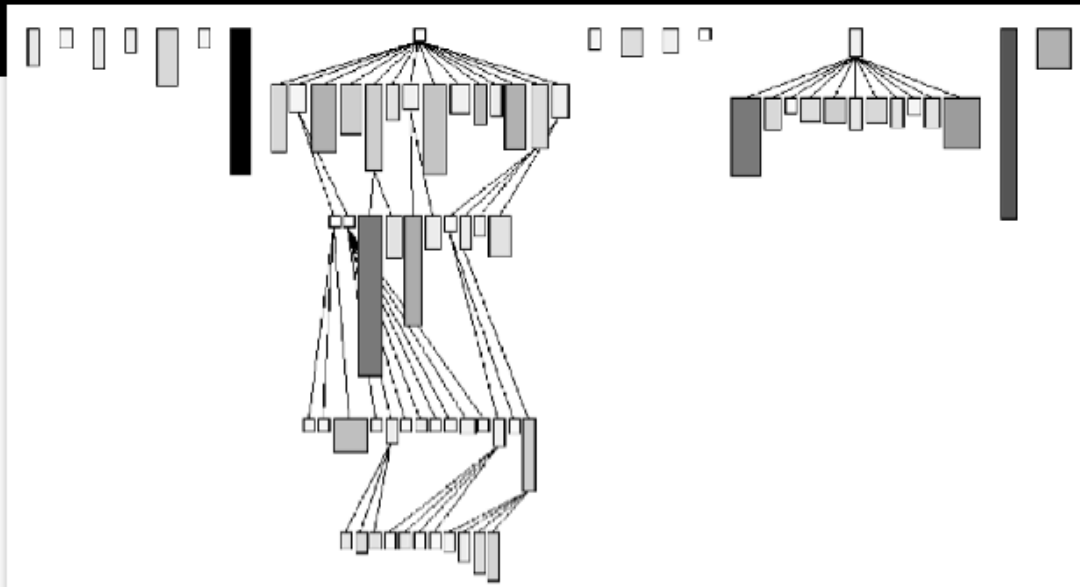
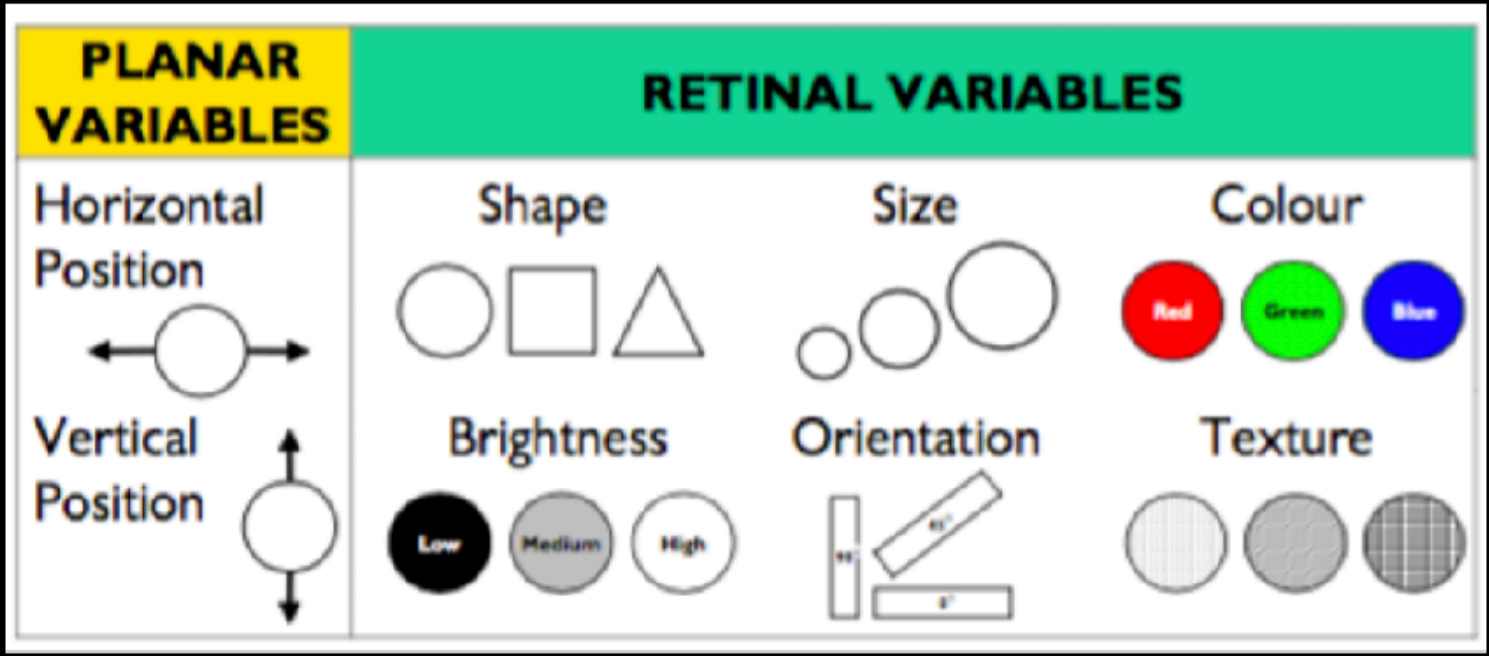


Figure 3.2: The SYSTEM COMPLEXITY view. This visualization of classes uses a tree layout. The edges represent inheritance relationships. The metrics we use to enrich the view are NOA (the number of attributes of a class) for the width and NOM (the number of methods of a class) for the height. The color shade represents WLOC (the number of lines of code of a class).

Information Encoding

Bertin identified 8 variables onto which information can be encoded in a symbol
Each has limits of discrimination



Types of Symbols

Type	Characteristics	Example	Visual Processing Effort	Translation Effort	Design Effort	Acceptable To
Realistic	Reasonably high definition	Photo, Scan	High	Low	Low	All Users
Iconic	Reduced image Recognisable	Road Sign Emoji	Low	Low	High	All Users
Sensory Code	Triggers same visual mechanisms as real objects	Picasso Line Drawing	Low	Low	Very High	Most Users
Arbitrary	Symbol is abstract and meaning must be learnt	Archimate Role	Low	High	Low	Expert Users

Physics of Notation

Moody proposed a Physics of Notation as a scientific model to guide the design of symbols and graphical notations

Semiotic Clarity (1 concept, 1 symbol)

Perceptual Discriminability (easy to tell apart)

Semantic Transparency (easy to identify meaning)

Complexity Management (limit complexity, break up etc.)

Cognitive Integration (guide viewer by e.g. layout, arrows)

Visual Expressiveness (use full gamut of capabilities)

Dual Coding (use graphic complemented by text)

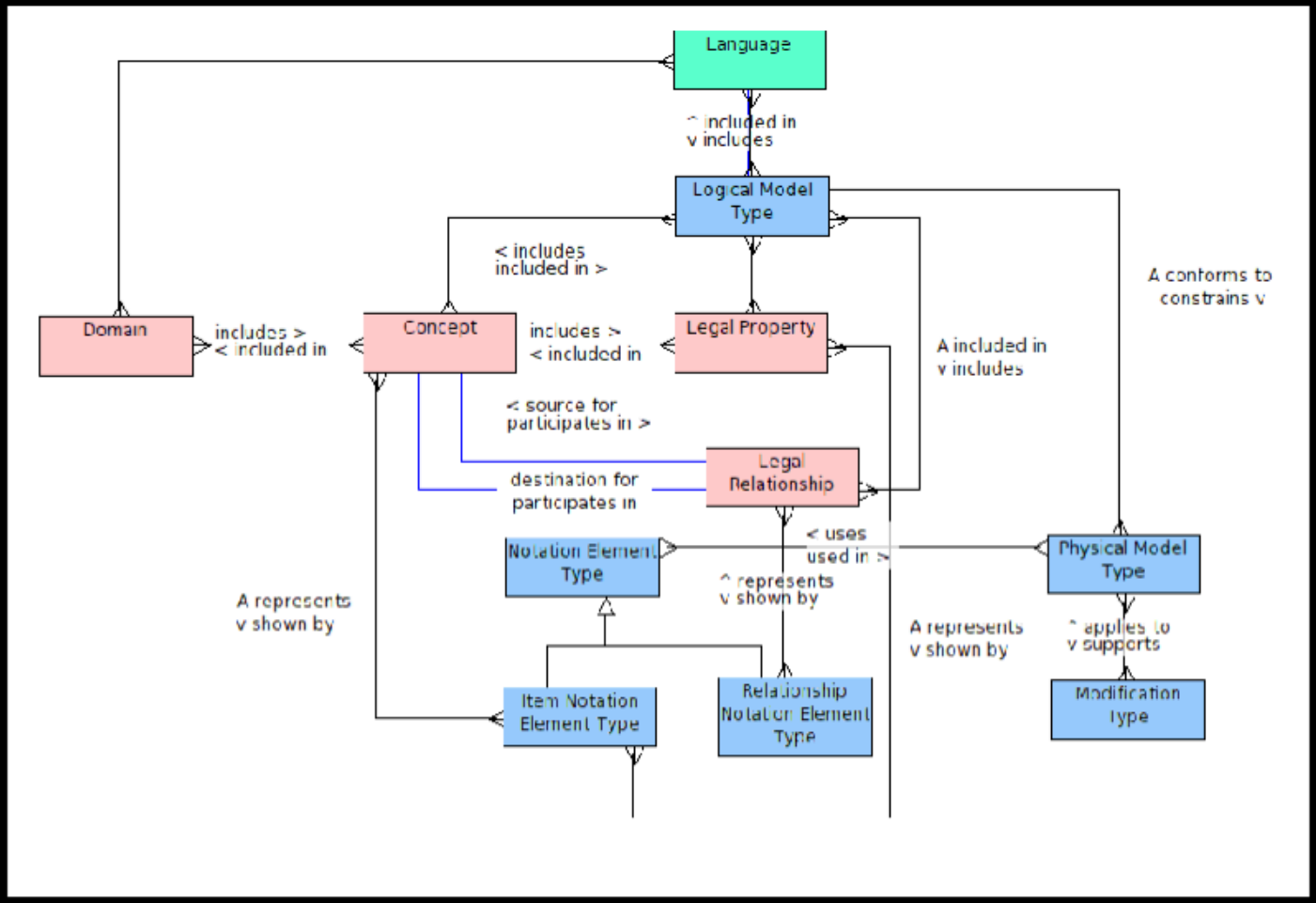
Graphic Economy (only enough notation to convey meaning)

Cognitive Fit (use symbols appropriate to audience/viewer knowledge and skill level)

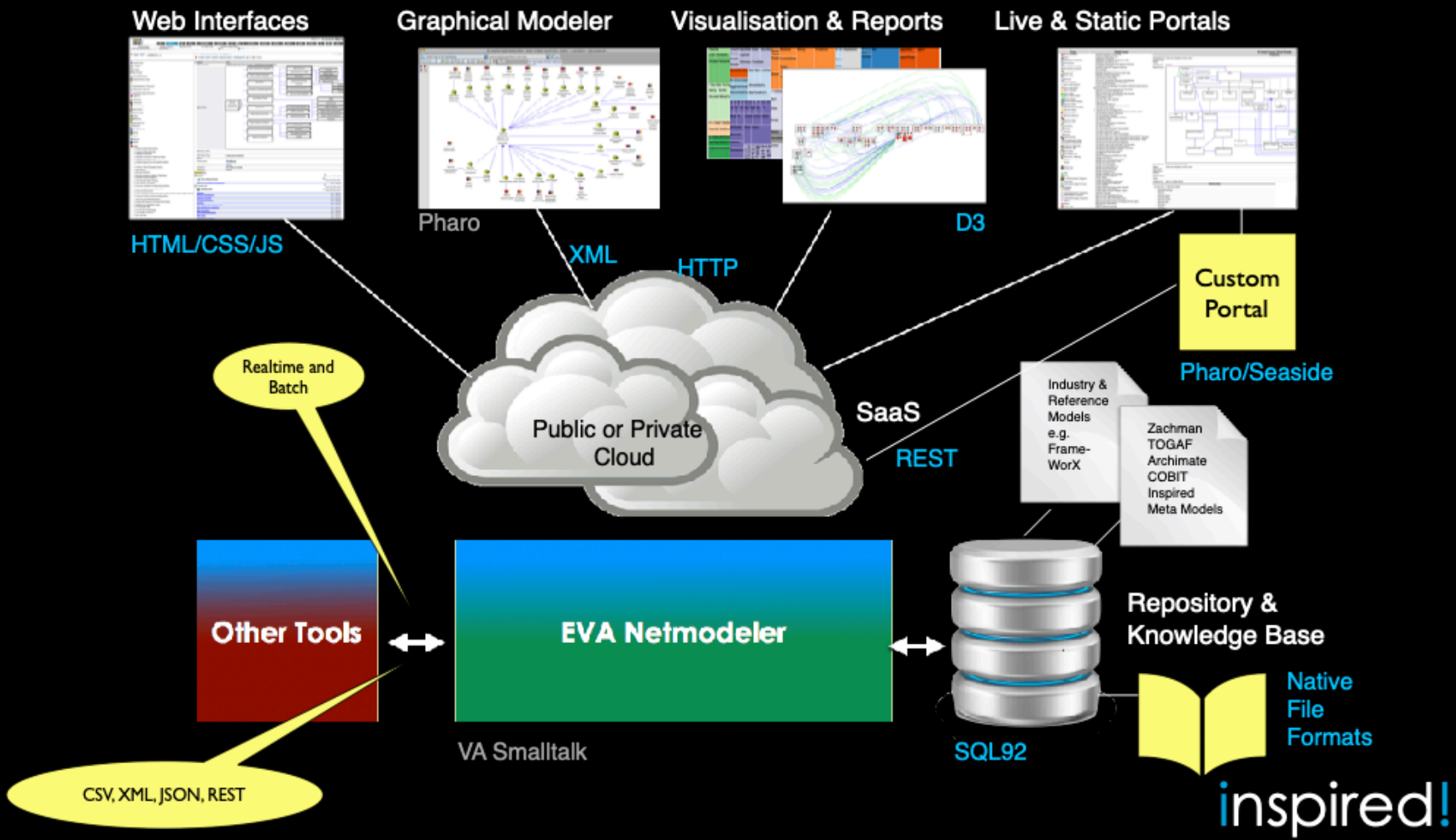
Cognitive Load

Miller	Limits of short term memory
Ware	Visualisation, Cognition, Awareness
Melamed	Optimisation of Visual Attention, Layout, Navigation Devices etc.
de Kinderen	Comparisons between casual and professional model users

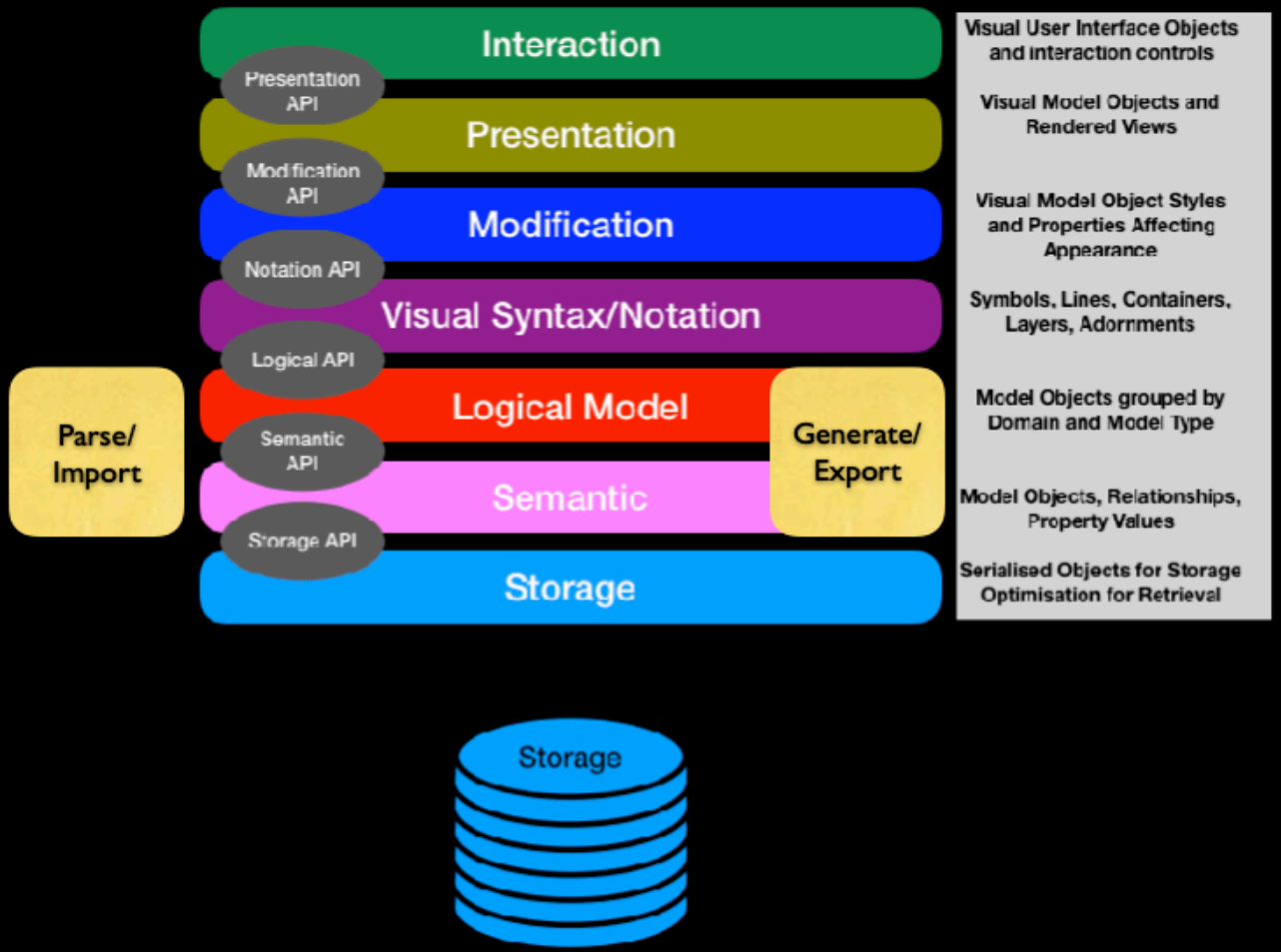
Representation Meta Model



EVA Netmodeler



Layered Tool Architecture



Contribution

Transfer of knowledge from human cognition / visual perception research to visual design in IS languages

Innovation WRT Polymetric Diagramming and techniques to facilitate analysis / insights / rapid query. Transfer from SW Engineering discipline to Enterprise Modeling. (Extension of Physics of Notation concepts)

Meta Model to capture abstractions and facilitate successful tool building

Descriptive (Level 4) Theory building in how modifications to visual models affect users

Prescriptive (Level 5) Theory building ito Guidance to researchers / practitioners on visual language design incorporating modifications to support discovery

Subtle learning from Prototyping and Expert feedback to inform approach and tool building

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Camouflage Lion Photo: https://fbcdn-sphotos-c-a.akamaihd.net/hphotos-ak-frc3/971650_533671470011763_1499037240_n.jpg

Code City example: http://www.moosetechnology.org/docs/visualhall

Mondrian Scripting Example: http://www.moosetechnology.org/docs/demos

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Faculty of Information Systems at UCT for 12 years (1991 - 2003)

Active in industry from 1975 - present. Roles of developer, designer, analyst, project manager, product manager, instructor/lecturer, consultant, architect, entrepreneur, general manager, director, chairman, business owner. Currently Chief Architect / Owner of inspired.org

Major interests: Modeling, Meta Modeling, Methods Engineering, Enterprise and Software Architecture, Business Modeling, Strategy, Tools, Dynamic Languages (Smalltalk)

http://www.travelstart.co.za/blog/wp-content/uploads/2013/11/Greg-Lumley.jpg

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