PMR 5020

Metodologia do Projeto de Sistemas

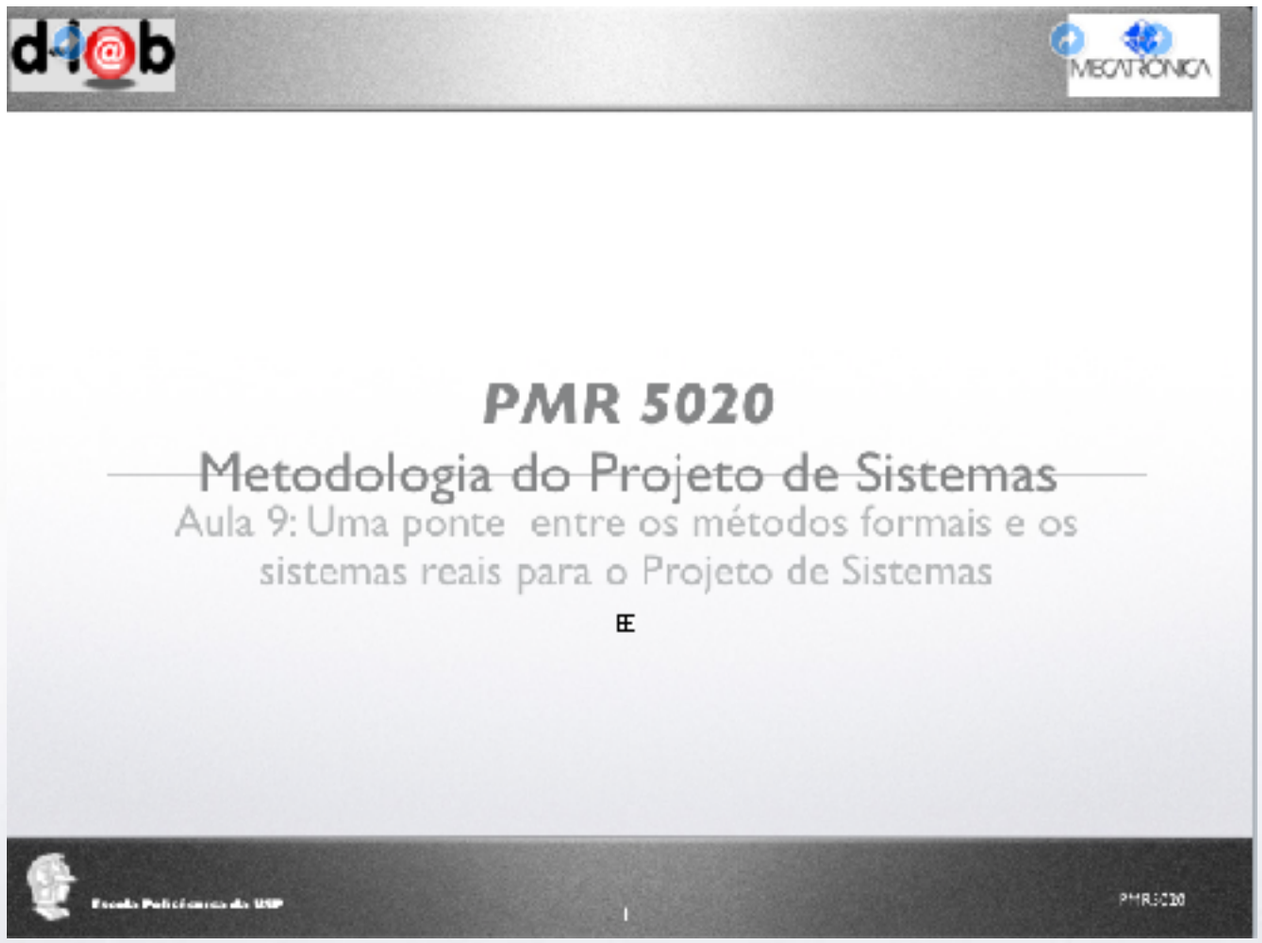
Aula 10: introducing MBSE, features and methods

Prof. José Reinaldo Silva
reinaldo@poli.usp.br

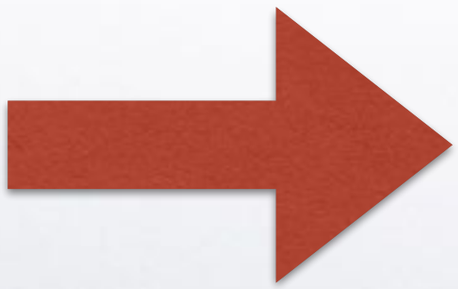
Calendário da PG-EPUSP

Inicio do Primeiro 1o. ciclo	19/02 para nós 22/02
Término (oficial) do 1o. ciclo	25/05 para nós 24/05
Prazo para entrega de notas	25/07
Prazo final para os artigos	02/06
Entrega de notas	20/06

A aula passada



A grande pergunta que permeia a aula de hoje é justamente como vamos resolver o problema de escalabilidade entre os métodos que vimos até aqui (e sem o que a discussão seria inviável) e o problema que temos que enfrentar de projetar grandes sistemas ou sistemas de sistemas.



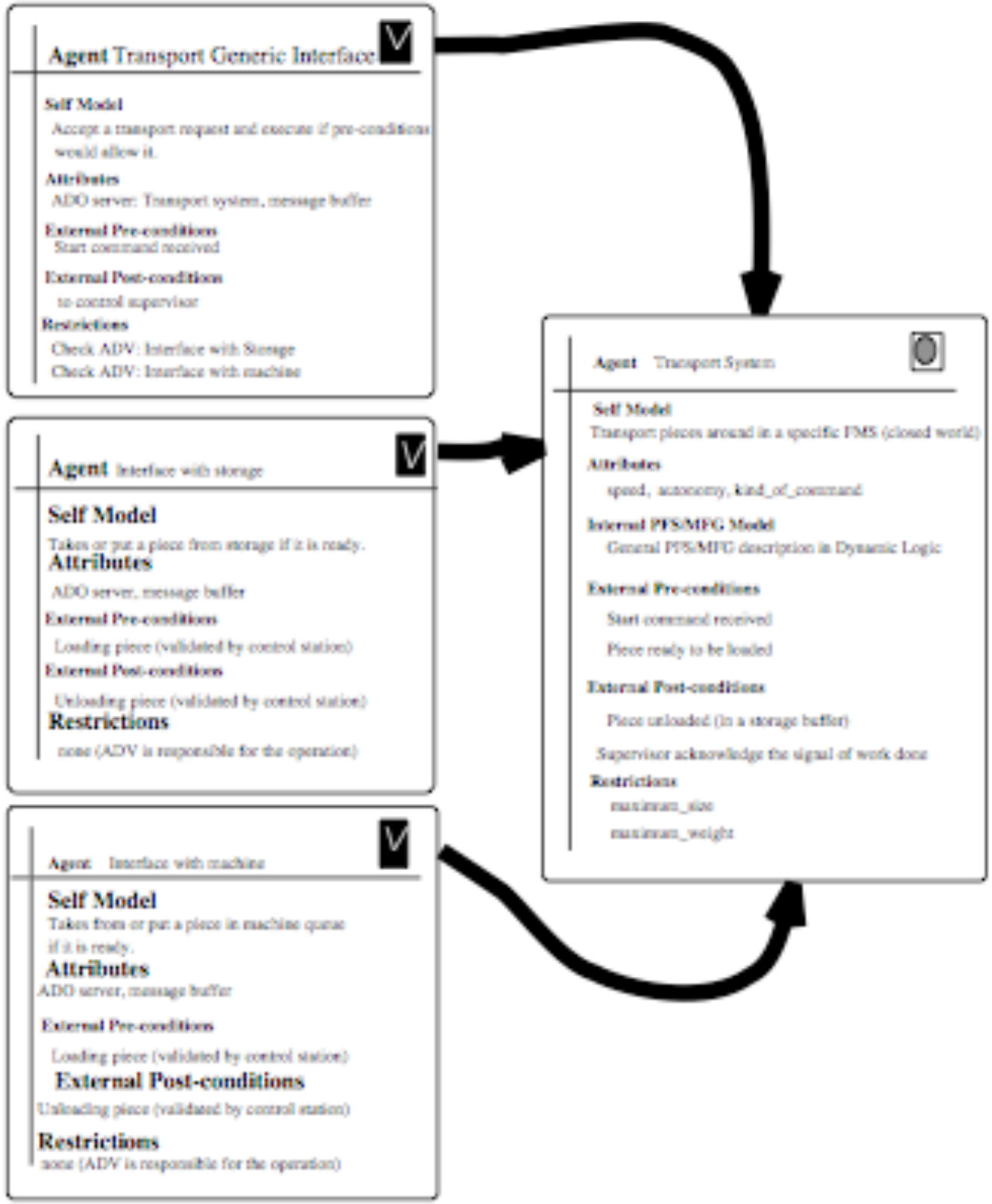
Model Driven Engineering

Conceitos (teóricos e práticos) básicos

- Separation of concerns (herdado da abordagem orientada a objetos)
- Formalização antecipada (na fase de requisitos)
- Equilíbrio entre abstração, "trecebility" e comunicação (dominios)
- Escolha de uma boa linguagem de design (formal)
- Sistemas de sistemas
- Introdução de serviços em substituição ou fusão com os "produtos".

Object interface-service relationship

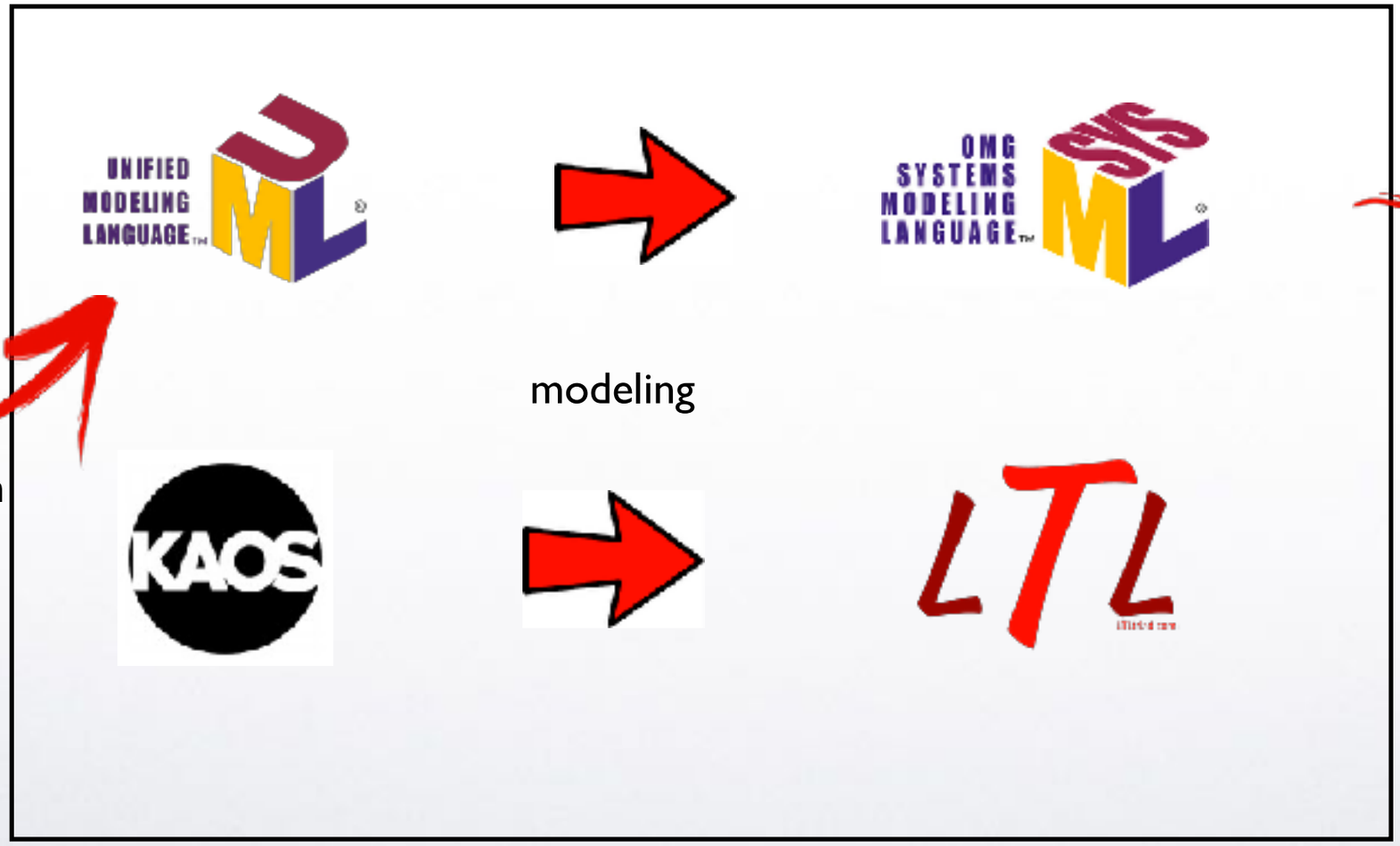
Separation of concerns
(herdado da abordagem orientada a objetos)



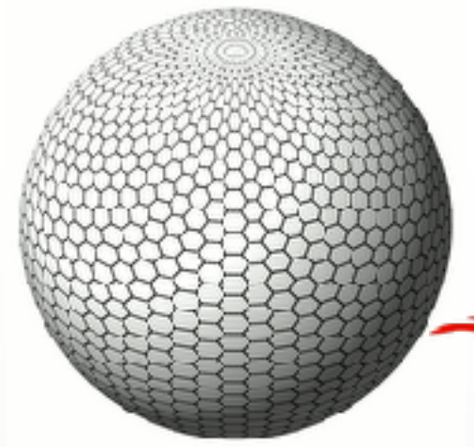
Silva, J.R., Afsarmanesh, H., Cowan, D.D., Lucena, C.J.P. (1995) An Object-Oriented Approach to the Design of Production Systems, in Balanced Automated Systems: Architecture and Design Methods, Camarinha-Matos, L. and Afsarmanesh, H. (eds.), Chapman & Hall, London.

Formalização antecipada (na fase de requisitos)

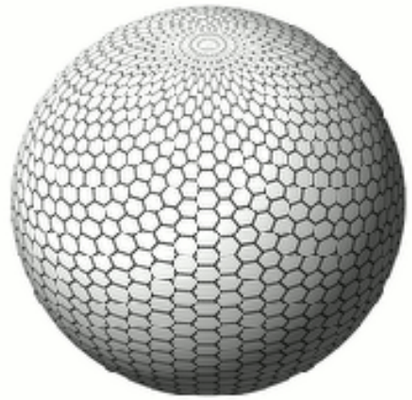
Requirements Engineering



Equilíbrio entre abstração, "trecebility" e comunicação (dominios)



requisitos



implementação



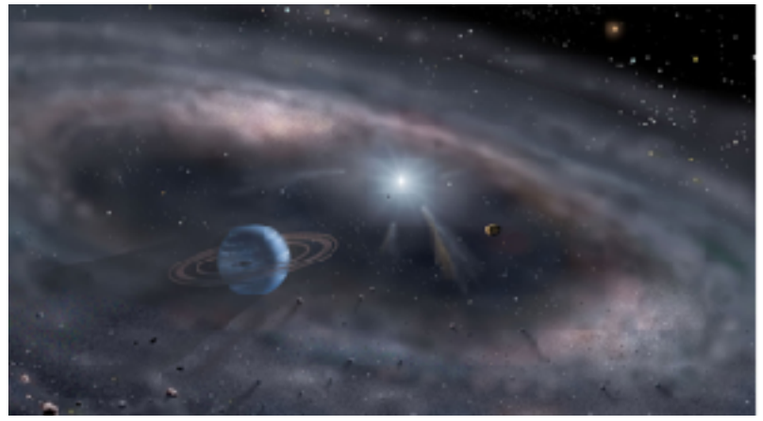
design

Escolha de uma boa linguagem de design (formal)

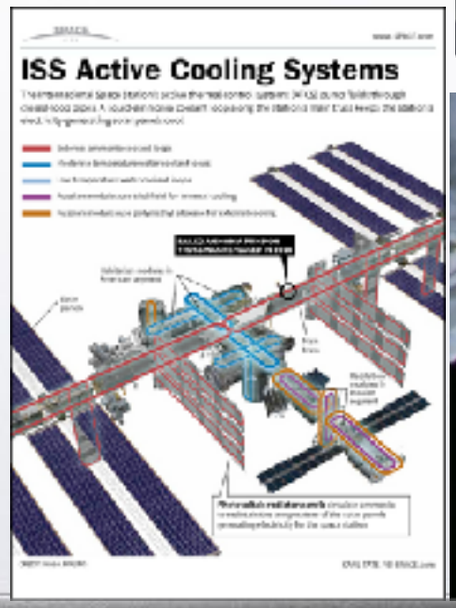
Method name	Concurrency	Executability	Usage of variables	Non-determinism
Action Systems	NO	YES	YES	YES
B	NO	YES	YES	YES
CASL	NO	YES	YES	NO
Cleanroom & JSD	NO	YES	YES	YES
COQ	NO	YES	YES	YES
Estelle	YES	YES	YES	NO
LOTOS	YES	YES	YES	YES
OMT & B	NO	YES	YES	YES
Petri Nets	NO	YES	NO	YES
Petri Nets with Objects	YES	YES	YES	YES
SART	YES	NO	NO	YES
SAZ	NO	YES	YES	YES
SCCS	YES	YES	YES	YES
SDL	YES	YES	NO	YES
UML	YES	NO	NO	NO
VHDL	YES	YES	YES	NO
Z	NO	YES	YES	YES

The System of Systems Challenge

A practical obstacle to the formalization of design is the practical effectiveness of this approach, specially in this era of complexity. Generally, formal approaches do not fit the complexity of large systems (of systems).

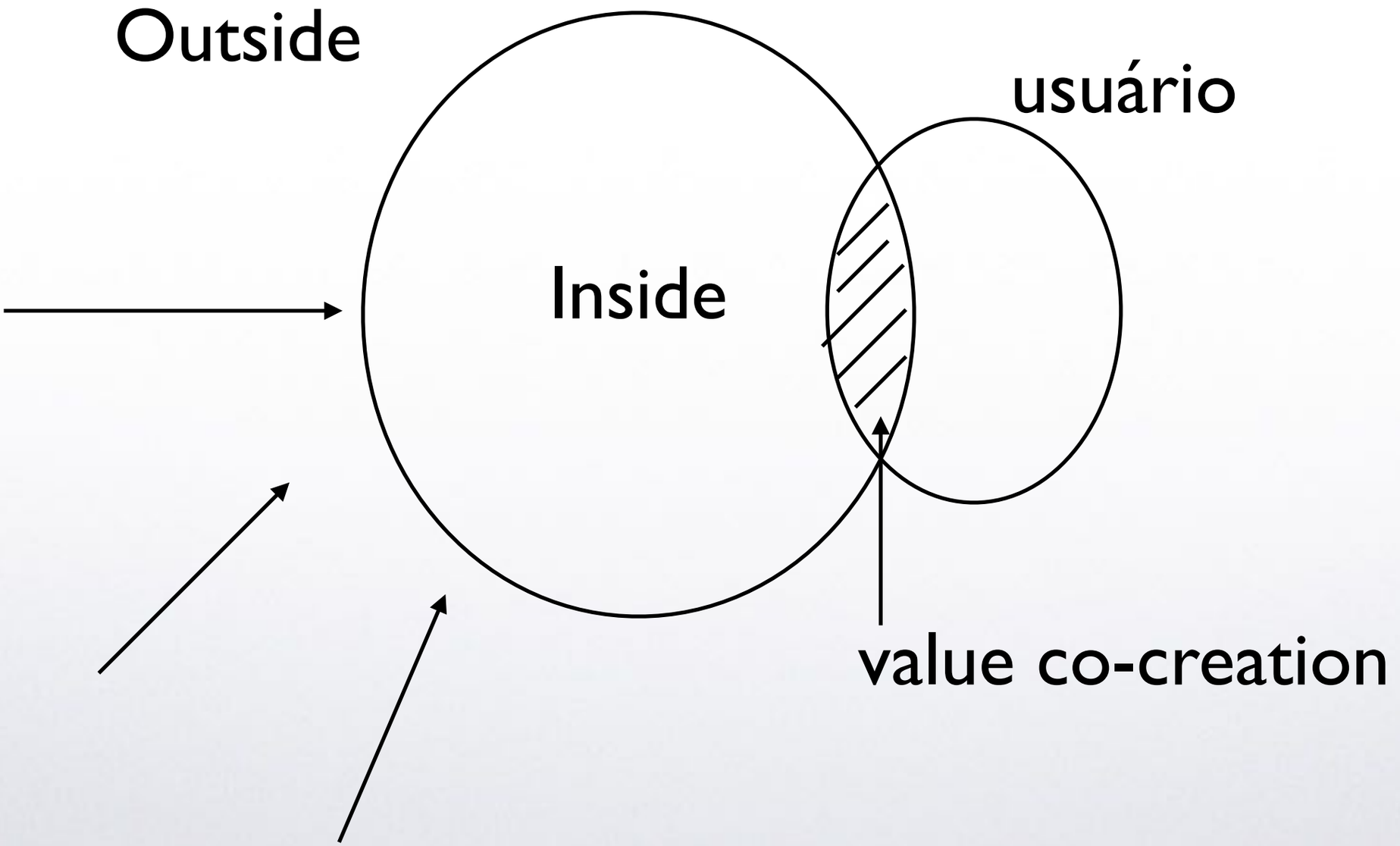








A System Service Model



A grande pergunta que permeia a aula de hoje é justamente como vamos resolver o problema de escalabilidade entre os métodos que vimos até aqui (e sem o que a discussão seria inviável) e o problema que temos que enfrentar de projetar grandes sistemas ou sistemas de sistemas.

Model Driven Systems Engineering

Improving Systems: Resilient Systems Concepts

Model Based Engineering



- Virtual designed products
- Product Lifecycle Management
- Immersive Design Centers
- Virtual Manufacturing
- Integrated Global Supply Chain
- Simulated Operational and Design Concepts

Platform Based Engineering



- Open Architecture principles
- Architectural, quality attribute driven patterns
- Reuse of Product Line assets
- Agile Software
- Architected and planned variant assets to support new missions and new products

Capability on Demand



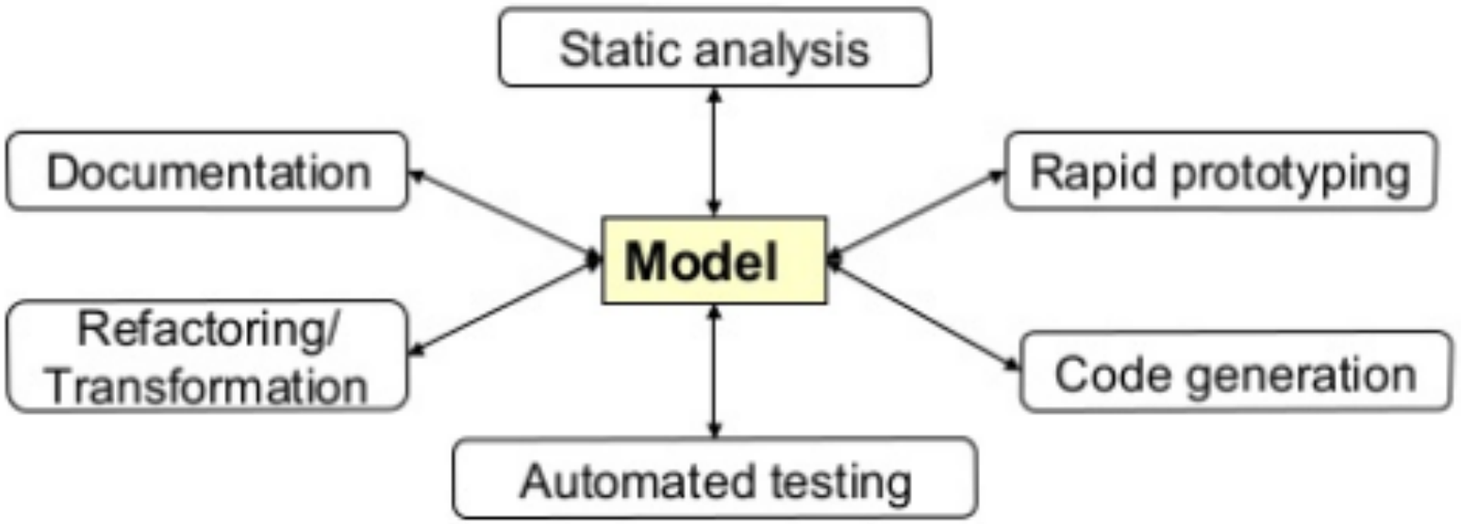
- Autonomous Systems
- Context Aware
- Integrated Health Management
- Self Adaptive Concepts
- Field Adaptive (Modular Payloads)

Trusted Systems Design



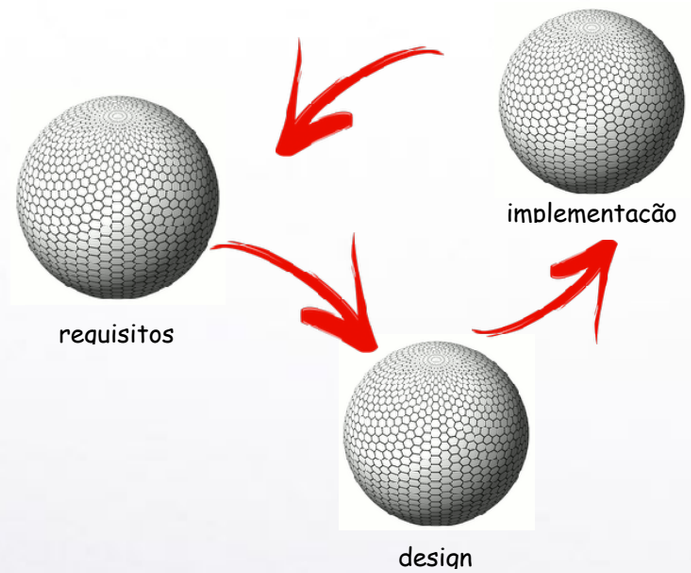
- Enterprise Network Security
- Infrastructure Operations Support
- Intrusion and Virus Detection
- System Integration
- Information Assurance
- Cyber Concepts applied from Enterprise IT

Innovative Systems Engineering Approaches



- Related terms
  - Model Driven Engineering (MDE),
  - Model Driven [Software] Development (MDD/MDSD),
  - Model Driven Architecture (MDA)
  - Model Integrated Computing (MIC)

Revendo o problema "prático" do Systems Design



O design "ideal" persegue arduamente correção e completeza, o que só se consegue com a formalização. No entanto, quanto mais formal o sistema mais difícil é a comunicação entre as grandes "esferas": requisito (o que tem que ser feito e porque), o design (como se consegue o sistema e seus objetivos de forma direta e com menor custo e maior eficiência), e a implementação (como fazer e como eliminar o sistema e como interagir de forma eficiente com o usuário final).

SE Practices for Describing Systems

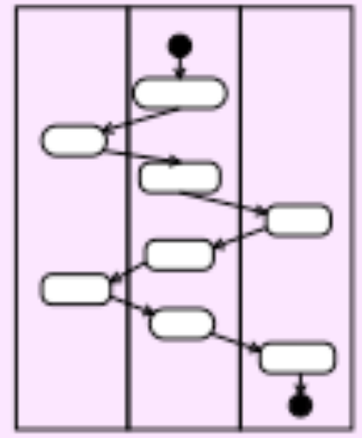
Past



Text

- Specifications
- Interface requirements
- System design
- Test plans
- Analysis & Trade-off

Future



Model

Portanto, o grande (falso) dilema é formalização versus boas práticas.

Porque falso? Porque o design não vive sem os dois.

A busca por uma Teoria Geral do Design

A discussão sobre a formalização do processo de design começou em 1981com a proposta de Hiroyuki Yoshikawa, e foi logo em seguida ampliada por Tetsuo Tomiyama, seu orientado. A polemica perdura até hoje e varia de alegações ao arcabouço teórico, à abordagem conceitual, até a perspectiva de aplicação.



Hiroyuki Yoshikawa



Tetsuo Tomiyama

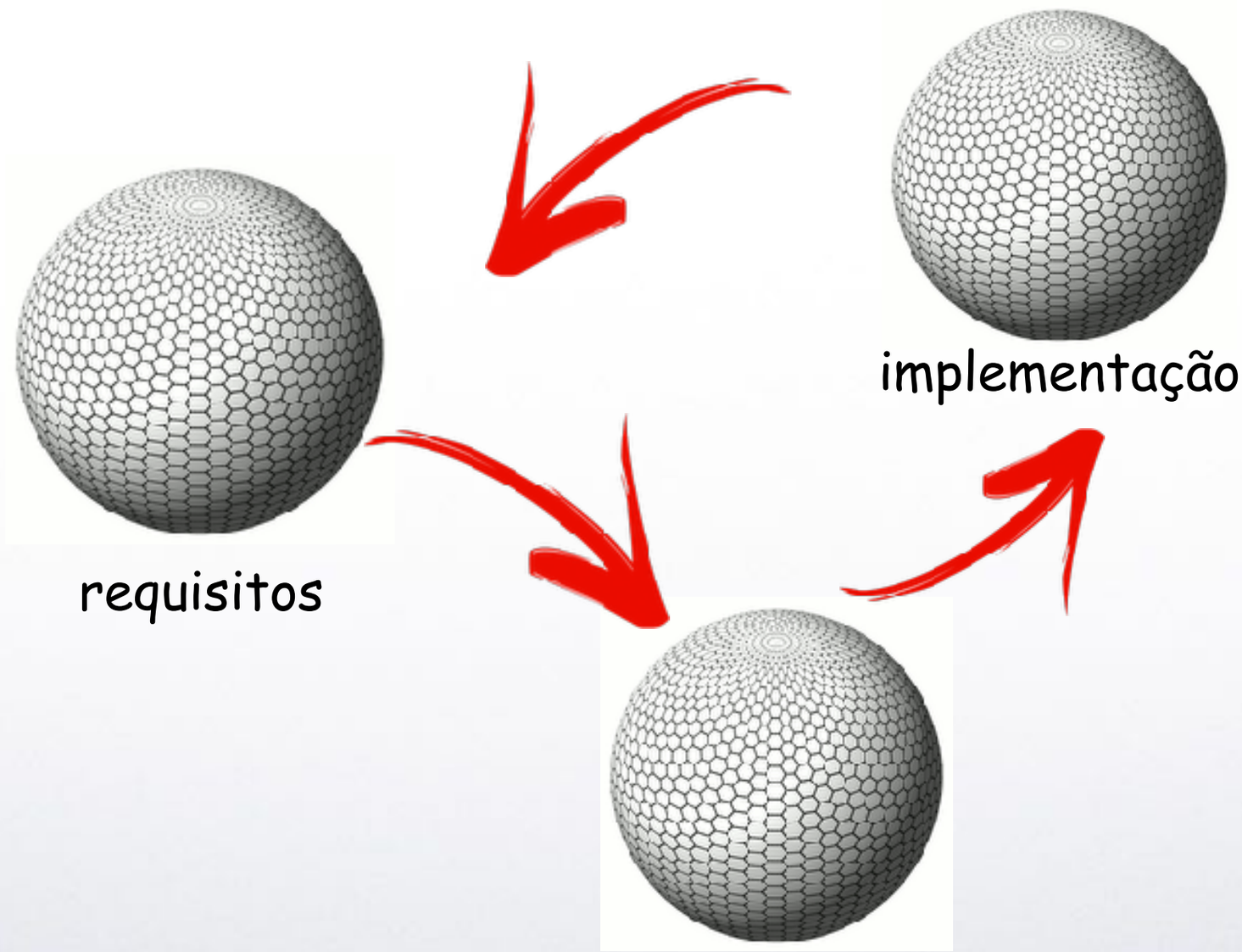
Yoshikawa, H. (1981). General Design Theory and a CAD system, In: *Man-Machine Communication in CAD/CAM*, Sata, T. and Warman, E. (eds.), pp. 35–58, North-Holland, Amsterdam.

Axiom 1 (Axiom of Recognition) Any entity can be recognized or described by the attributes.

Axiom 2 (Axiom of Correspondence) The entity set S' and the set of concept of entity (ideal) S have one-to-one correspondence.

Axiom 3 (Axiom of Operation) The set of abstract concept is a topology of the set of entity concept.

Equilíbrio entre abstração, "trecebility" e comunicação (dominios)



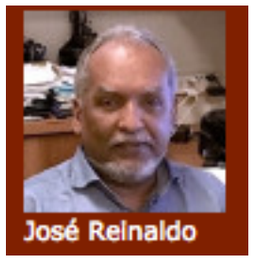
Alguns aspectos práticos

Analytic Approach	*Systemic Approach*
• isolates, then concentrates on the elements	• unifies and concentrates on the interaction between elements
• studies the nature of interaction	• studies the effects of interactions
• emphasizes the precision of details	• emphasizes global perception
• modifies one variable at a time	• modifies groups of variables simultaneously
• remains independent of duration of time; the phenomena considered are reversible.	• integrates duration of time and irreversibility
• validates facts by means of experimental proof within the body of a theory	• validates facts through comparison of the behavior of the model with reality
• uses precise and detailed models that are less useful in actual operation (example: econometric models)	• uses models that are insufficiently rigorous to be used as bases of knowledge but are useful in decision and action (example: models of the Club of Rome)
• has an efficient approach when interactions are linear and weak	• has an efficient approach when interactions are nonlinear and strong
• leads to discipline-oriented (juxtadisciplinary) education	• leads to multidisciplinary education
• leads to action programmed in detail	• leads to action through objectives
• possesses knowledge of details poorly defined goals	• possesses knowledge of goals, fuzzy details

Portanto, um bom projeto de sistema começa com uma descrição geral de objetivos que pode ser colocada em um WBS ou em qualquer outro formato. Este seria o "modelo original".

Mas, na maior parte dos casos um novo sistema é requerido para "substituir" um outro já existente que se tornou obsoleto. Portanto o processo deve começar pela modelagem do "system-as-is", isto é, do sistema legado. Os "novos requisitos" devem então demarcar as diferenças entre os "system-as-is" e o "system-to-be".

E o que acontece se não existir o "system-as-is"? Existiria um processo de inovação geral, onde um novo sistema é demandado pela primeira vez?



Se não existir o "system-as-is", então faça um modelo com os requisitos extraídos do stakeholder. Este será o system-as-is! O system-to-be será o resultado da otimização e engenharia das soluções após alguma eventual negociação.

Fundamentação matemática para o MBSE

A. Wayne Waymore (T3SD) Tricotyledon Theory of System Design

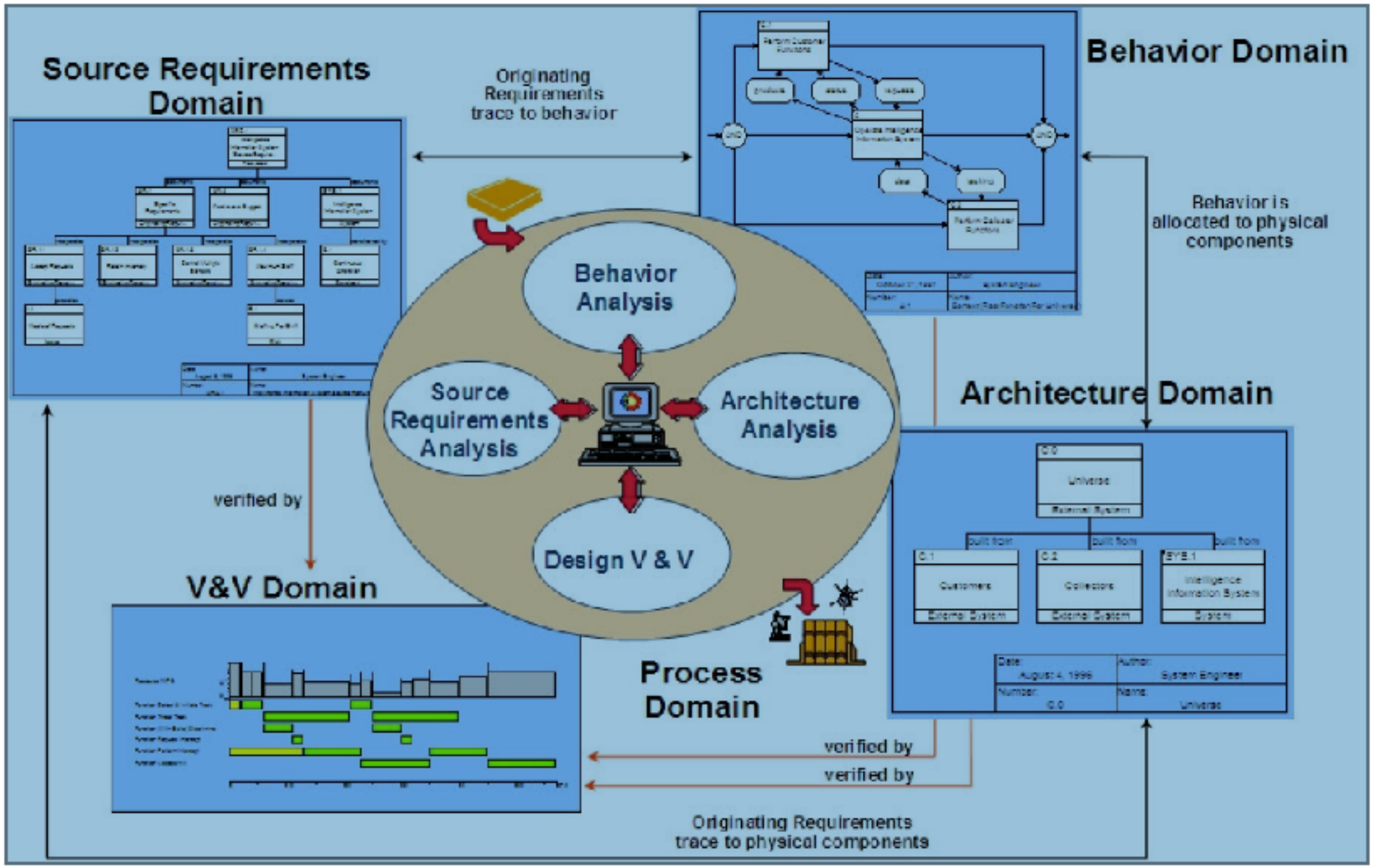
Wymore, A. Wayne, A Mathematical Theory of Systems Engineering: The Elements , John Wiley & Sons: New York, NY, 1967.

Wymore, A. Wayne, Model-Based Systems Engineering , CRC Press, Inc.: Boca Raton, FL, 1993.

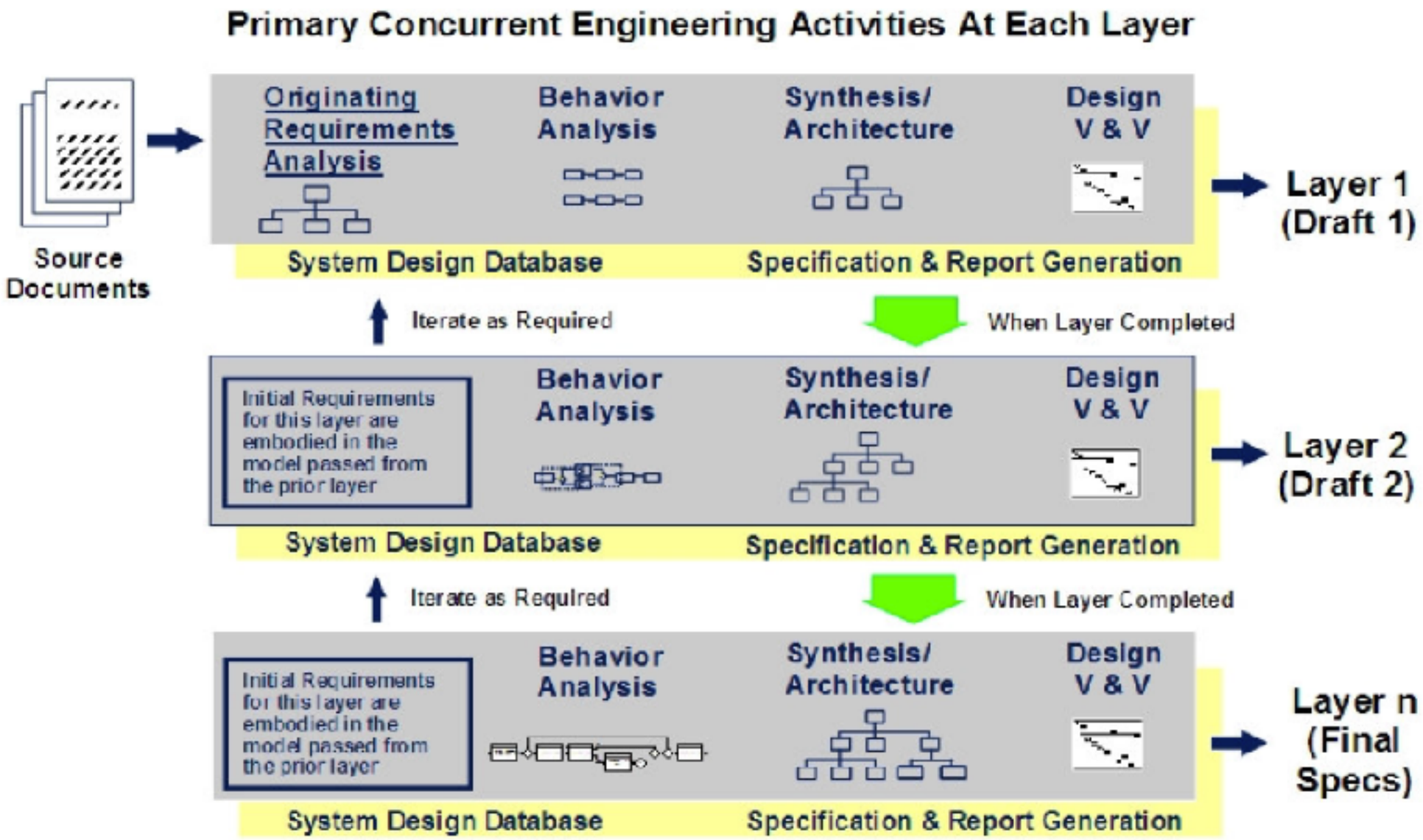
Wymore, A. Wayne, “Contributions to the Mathematical Foundations of Systems Science and Systems Engineering,” Systems Movement: Autobiographical Retrospectives, The University of Arizona, Tucson, AZ, 2004.

The basis of system theory and systems engineering, according to Wymore, is modeling, and the concept of “system” is human interpretation via senses (i.e., a mental model). A system model is a description that separates the perceived universe into two parts, the part “inside” the system and the part “outside” the system. From the “outside” the system receives inputs. To the “outside” the system delivers outputs. The “inside” of the system is described, initially, as states. The state of the system at any time is a function of its state at a previous time and the intervening inputs (including “noise”). System designs are system models. When modelers describe some part of reality as a “real” system, it means that their system mode “adequately” represents the reality. For the purpose of accurate communication, mathematical definitions of various classes of system models are postulated.

VITECH Model (CORE)



VITECH Onion Model



VITECH completion criteria

Process Element	Completion Criteria
1. Originating Requirements	1. Agreement on Acceptance Criteria.
2. Behavior/Functional Architecture	2. Each function is uniquely allocated to at most one component.
3. Physical Architecture Definition	3. Segment/component specs are complete requirements documents.
4. Qualification	4. V&V requirements have been traced to test system components.

Test Routines

Functional Testing	Test conditions are set up to ensure that the correct outputs are produced, based upon the inputs of the test conditions. Focus is on whether the outputs are correct given the inputs (also called "black box" testing).
Structural Testing	Examines the structure of the system and its proper functioning. Includes such elements as performance, recovery, stress, security, safety, availability. Some of the less obvious elements are described below.
Performance	Examination of the system performance under a range of nominal conditions, ensures system is operational as well.
Recovery	Various failure modes are created and the system's ability to return to an operational mode is determined.
Interface	Examination of all interface conditions associated with the system's reception of inputs and sending of outputs.
Stress Testing	Above-normal loads are placed on the system to ensure that the system can handle them; these above-normal loads are increased to determine the system's breaking point; these tests proceed for a long period of time in an environment as close to real as possible.

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"Additive Manufacturing Technologies: 3... | www.tempastic.org/papers/CMU-CS-04... | www.omgsysml.org/Pearce House ISO... | Wayne Waymore - Pesquisa Google | Vitech Corporation

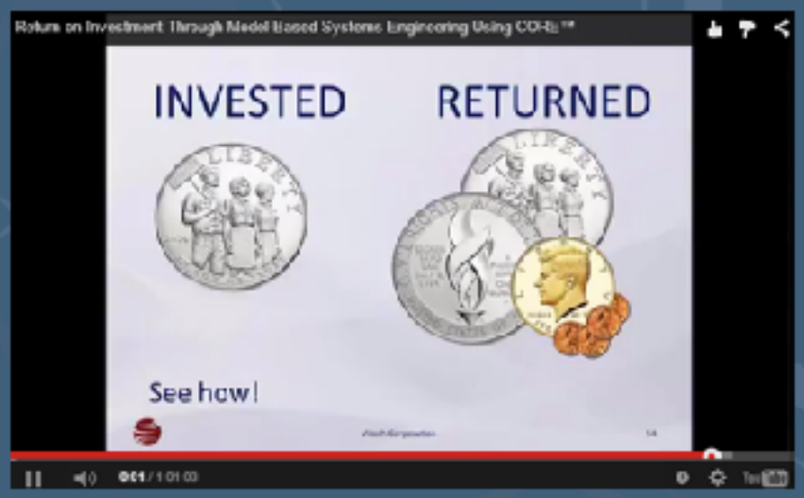
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Solutions for Model-Based Systems Engineering

Vamos retomar o processo de revisão dos artigos. Uma leitura da semana sobre MBSE será colocada no site, além do SEBok.



Obrigado

Reinaldo