PMR 5020

Metodologia do Projeto de Sistemas

Aula 10: Featuring Model Driven Design

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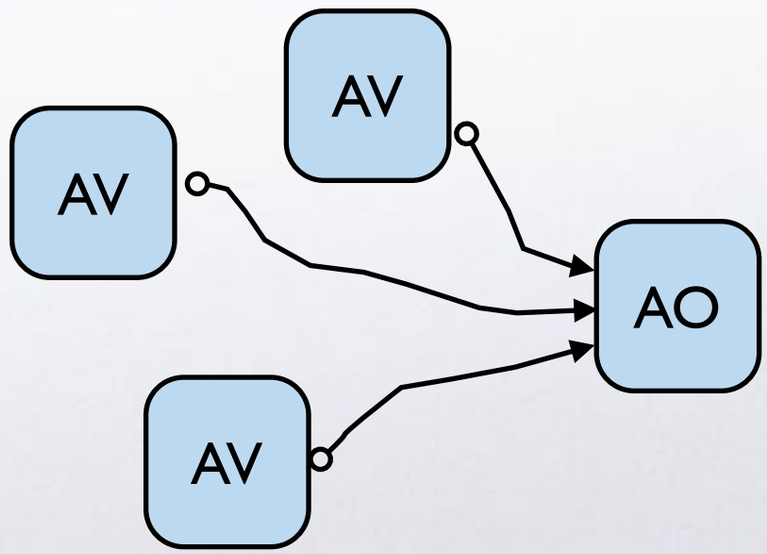
Alternativas para o Design de Sistemas

Até aqui vimos as seguintes alternativas para o design de sistemas:

I. investir na fase inicial, na eliciação de requisitos, análise e especificação;
II. a possibilidade de usar várias linguagens na fase de que vem após a especificação;
III. a *esperança* de que a formalização inerente ao processo não seja o motivo de perda de informação ou desvio dos requisitos iniciais;
IV. a possibilidade (especialmente para sistemas automatizados) de sofisticar o controle introduzindo sistemas inteligentes;

Existe de fato um processo de design formal?



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

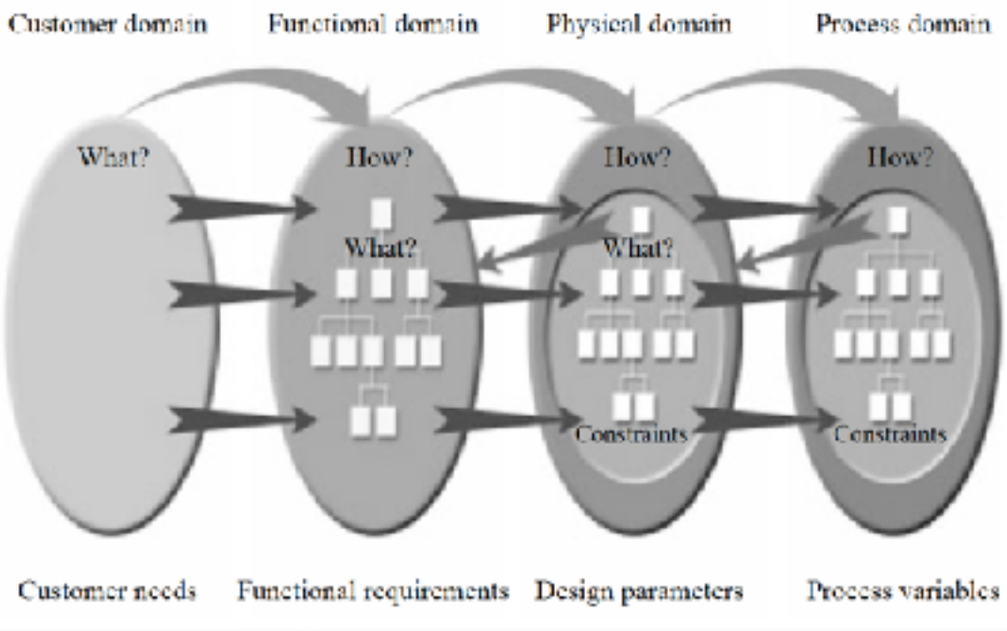
Yoshikawa, H. (1981). General Design Theory and a CAD system, In: *Man-Machine Communication in CAD/CAM*, Sata, T. and Warman, E. (eds.), pp. 35–58, North-Holland, Amsterdam.

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.

Axiomatic Design



$$\mathbf{FR = A\,DP}$$

$$\begin{bmatrix} FR_1 \\ FR_2 \\ FR_3 \end{bmatrix} = \begin{bmatrix} A_{11} & A_{12} & A_{13} \\ A_{21} & A_{22} & A_{23} \\ A_{31} & A_{32} & A_{33} \end{bmatrix} \begin{bmatrix} DP_1 \\ DP_2 \\ DP_3 \end{bmatrix}$$

Systems

According to INCOSE a system is

…an integrated set of elements, subsystems, and assemblies that accomplish a defined objective. These elements include products (hardware, software, firmware…), processes, people, information, technique, facilities, service, and other support elements. (INCOSE)

→ uncoupling

ciências naturais				engenharia					outras áreas				interface	Pesquisa em Sistemas em geral
física	química	biologia	. . .	elétrica	mecânica	civil	mecatrônica	. . .	política	psicologia	medicina	. . .		
													abstração →	Sistemas genéricos
													← instanciação	

What is System Engineering?

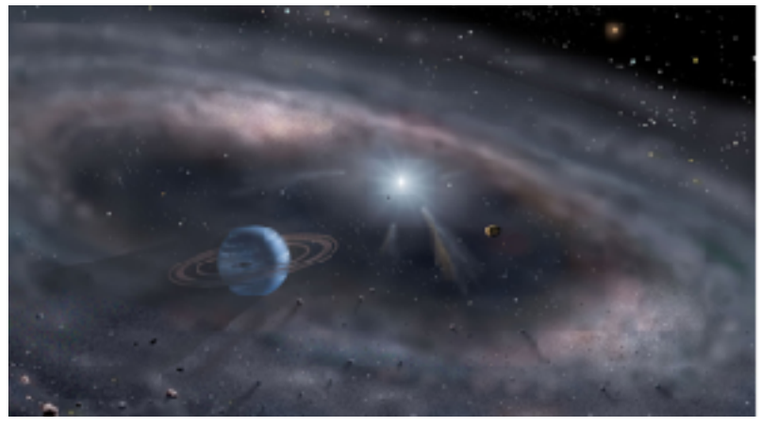
Systems engineering is a methodical, disciplined approach for the design, realization, technical management, operations, and retirement of a system.

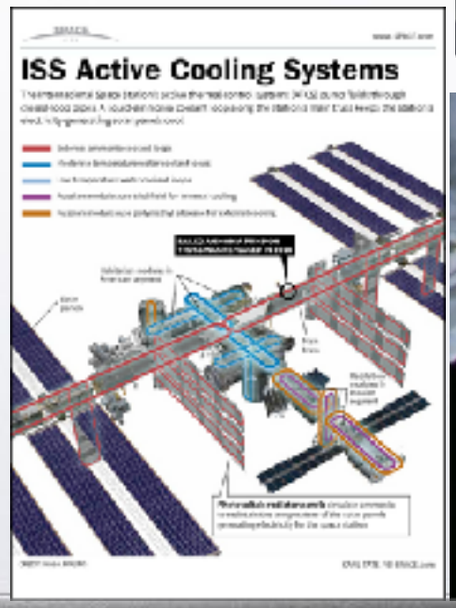
What is a System ?

A “system” is a construct or collection of different elements that together produce results not obtainable by the elements alone. The elements, or parts, can include people, hardware, software, facilities, policies, and documents; that is, all things required to produce system-level results.

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).





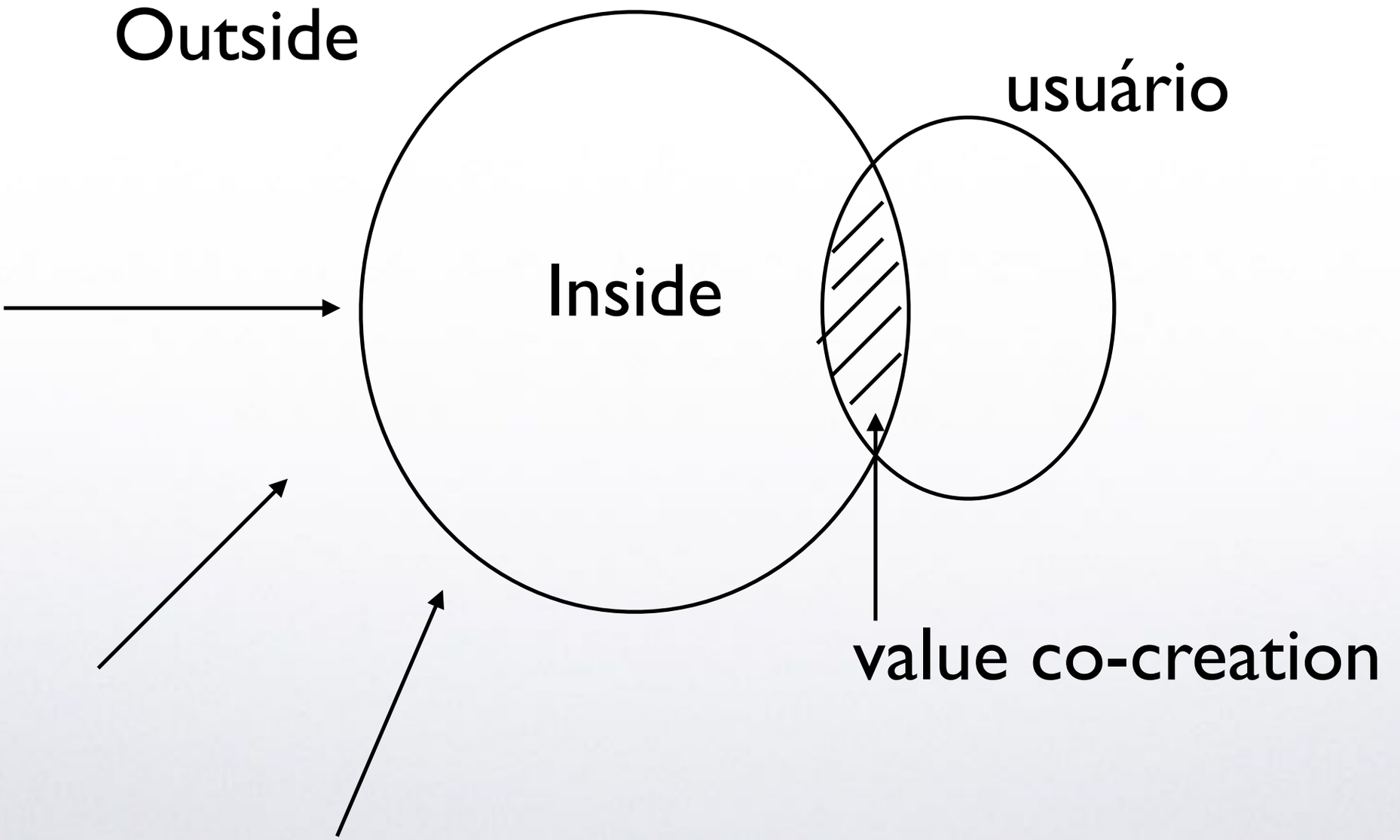
Designing large Service Information Systems

Novo SIS

Sistemas de informação conjugam flexibilidade e capacidade de integração, fundamental para inovação e automação.[1]
Convergência entre sistemas de serviço e sistemas de informação. [2]

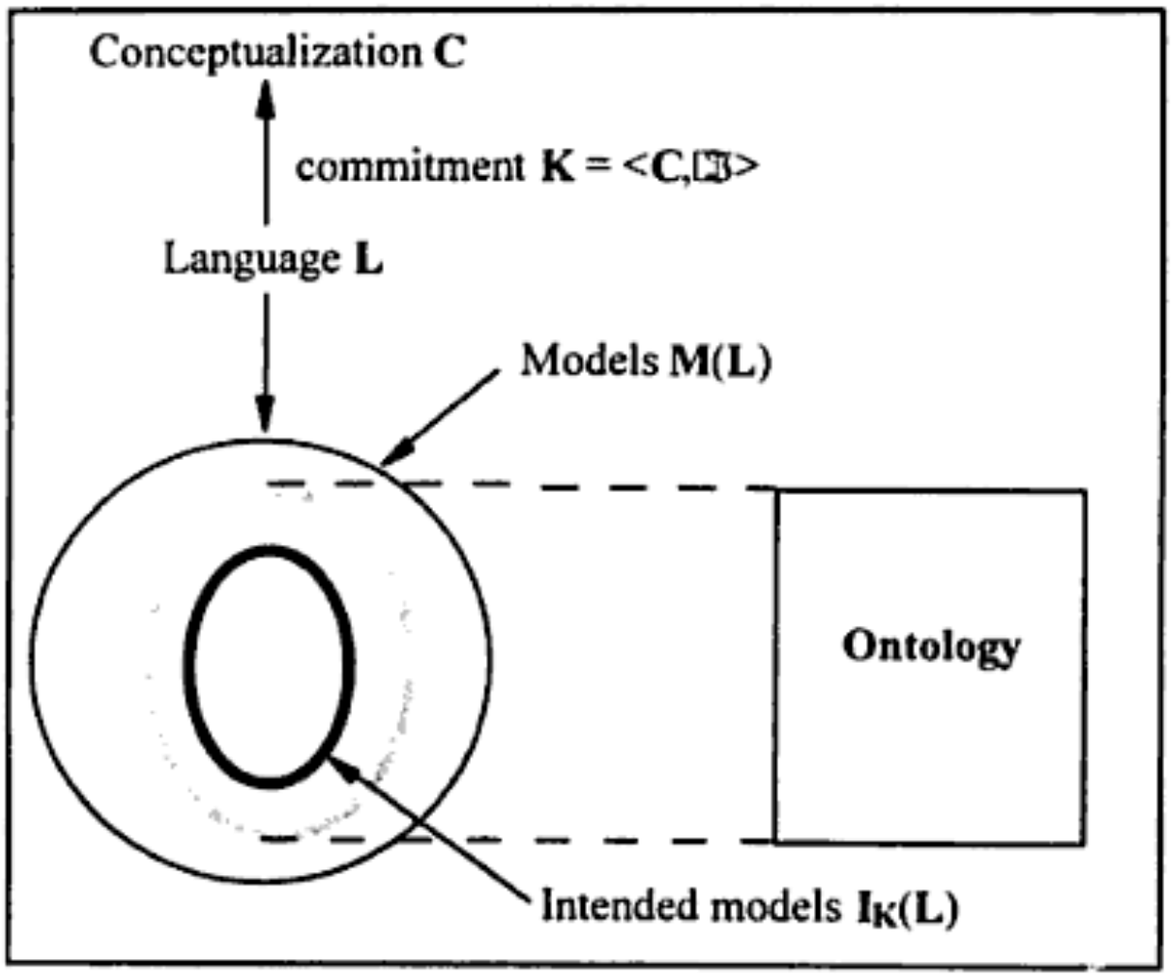
[1] Stair, R.; Reynolds, G. "*Information Systems*", 9th ed., *Course Technology*, 2010.
[2] Bardhan, I. ; Demirkan, H.; Kannan, P.; Kauffman, R.; Sougstad, R. "*An Interdisciplinary Perspective on IT Services Management and Service Science*". *Journal of Management Information Systems*, v. 26, n. 4, p. 13-64, 2010.

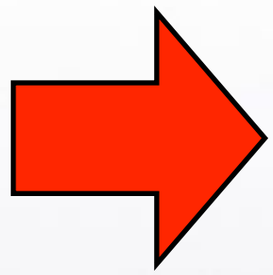
A System Service Model



. . . or designing really intelligent systems

Ontology driven IS





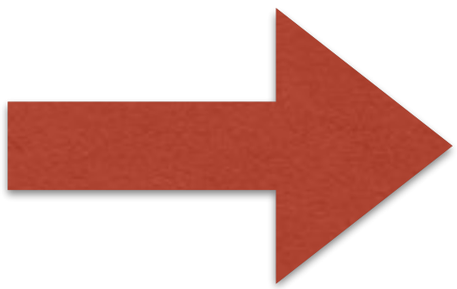
Artificial Intelligence

The System Engineering Approach

"Systems Engineering (SE) is an interdisciplinary approach and means to enable the realization of successful systems. It focuses on holistically and concurrently understanding stakeholder needs; exploring opportunities; documenting requirements; and synthesizing, verifying, validating, and evolving solutions while considering the complete problem, from system concept exploration through system disposal". (INCOSE 2012, modified)

SEBoK-2015

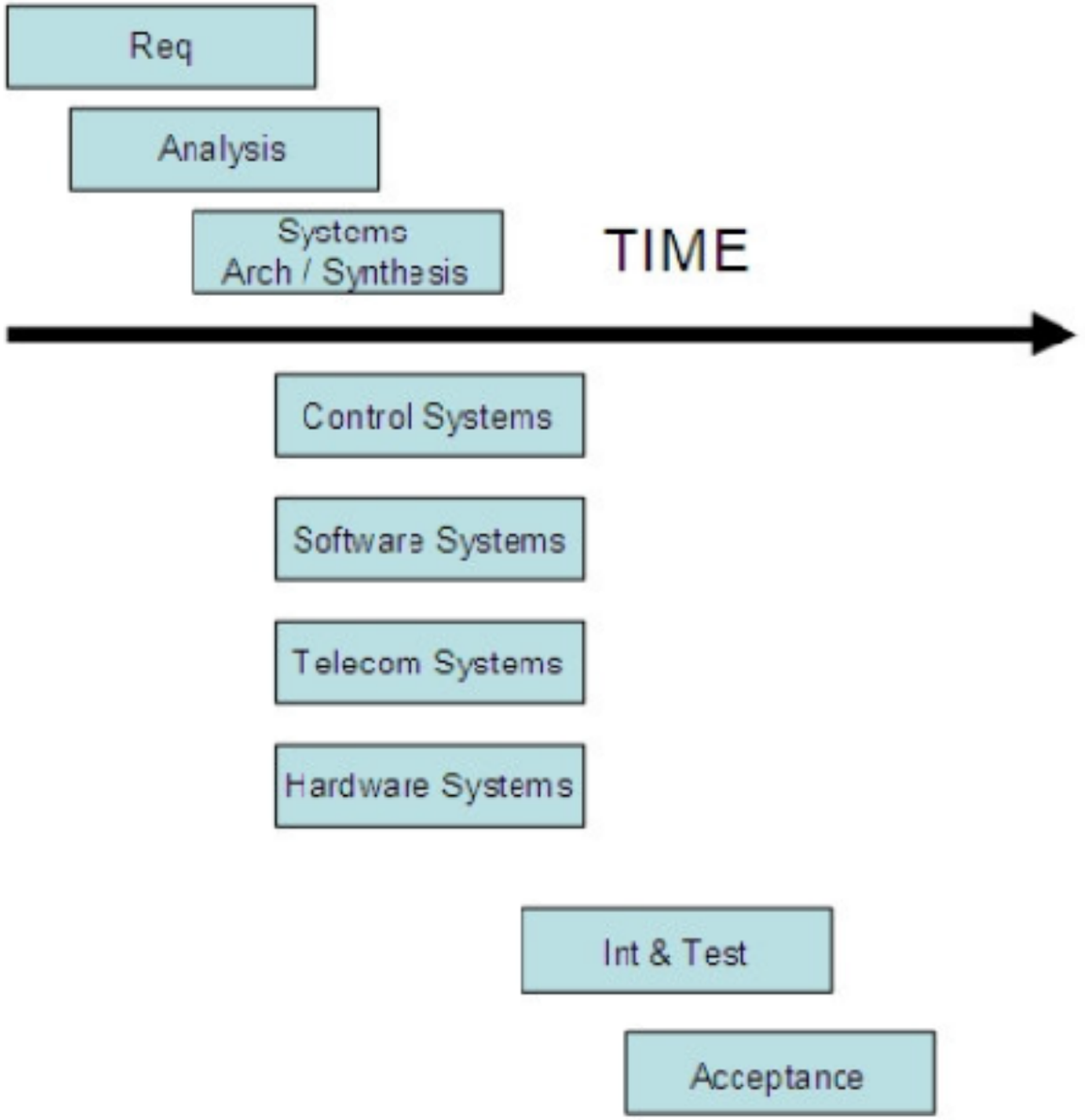
A grande pergunta que permeia a aula de hoje é justamente como vamos resolver o problema de escalabilidade entre os métodos que vimos até aqui (e sem o que a discussão seria inviável) e o problema que temos que enfrentar de projetar grandes sistemas ou sistemas de sistemas.

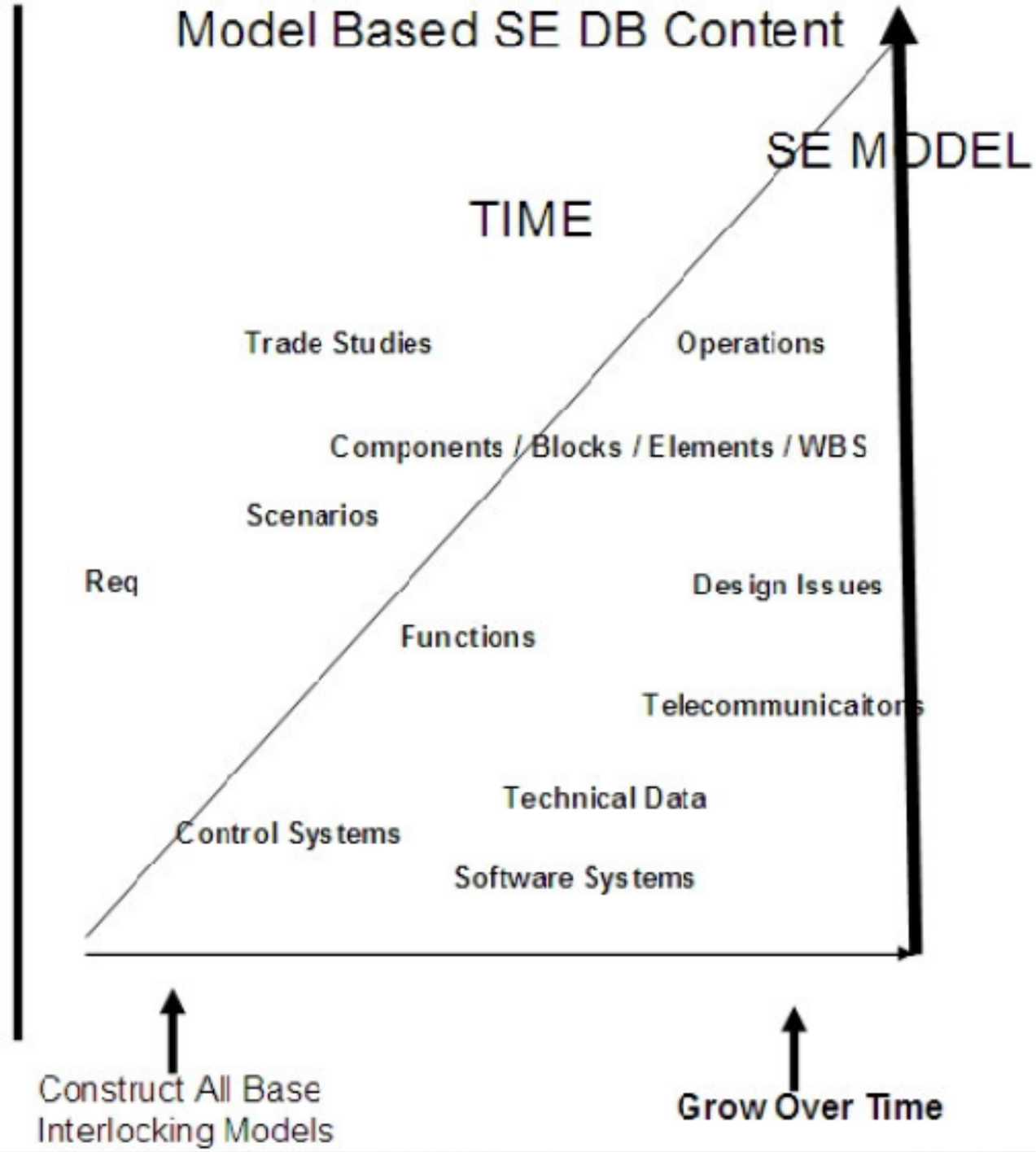


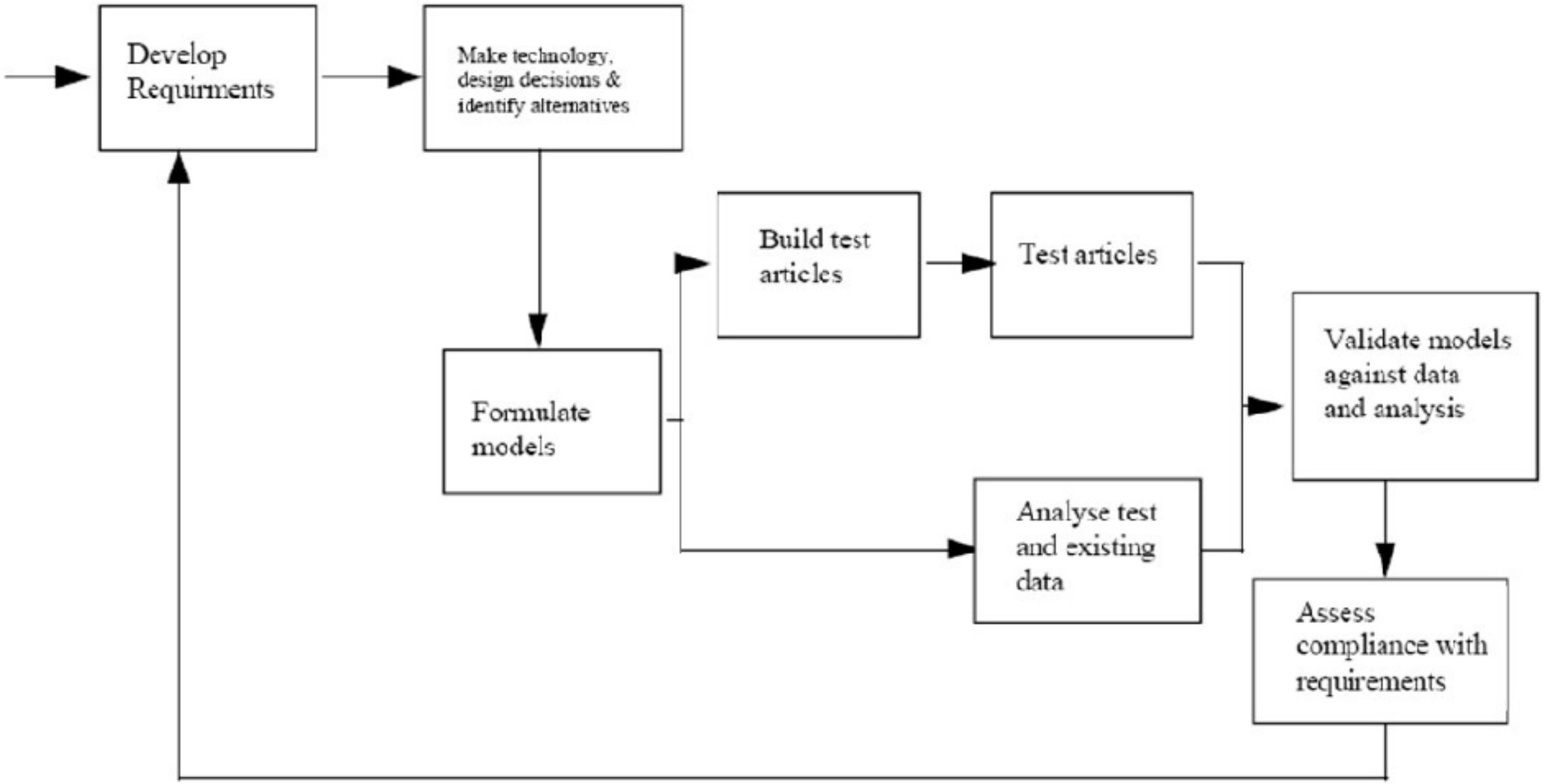
Model Driven Engineering

In a nutshell, model-based engineering (MBE) is about elevating models in the engineering process to a central and governing role in the specification, design, integration, validation, and operation of a system. For many organizations, this is a paradigm shift from traditional document-based and acquisition lifecycle model approaches, many of which follow a “pure” waterfall model of system definition, system design, and design qualification. One of the biggest communication barriers that exists between the traditional engineering design disciplines (including the discipline of systems engineering) and MBE is that in a model based process, activities that support the engineering process are to be accomplished through development of increasing detailed models.

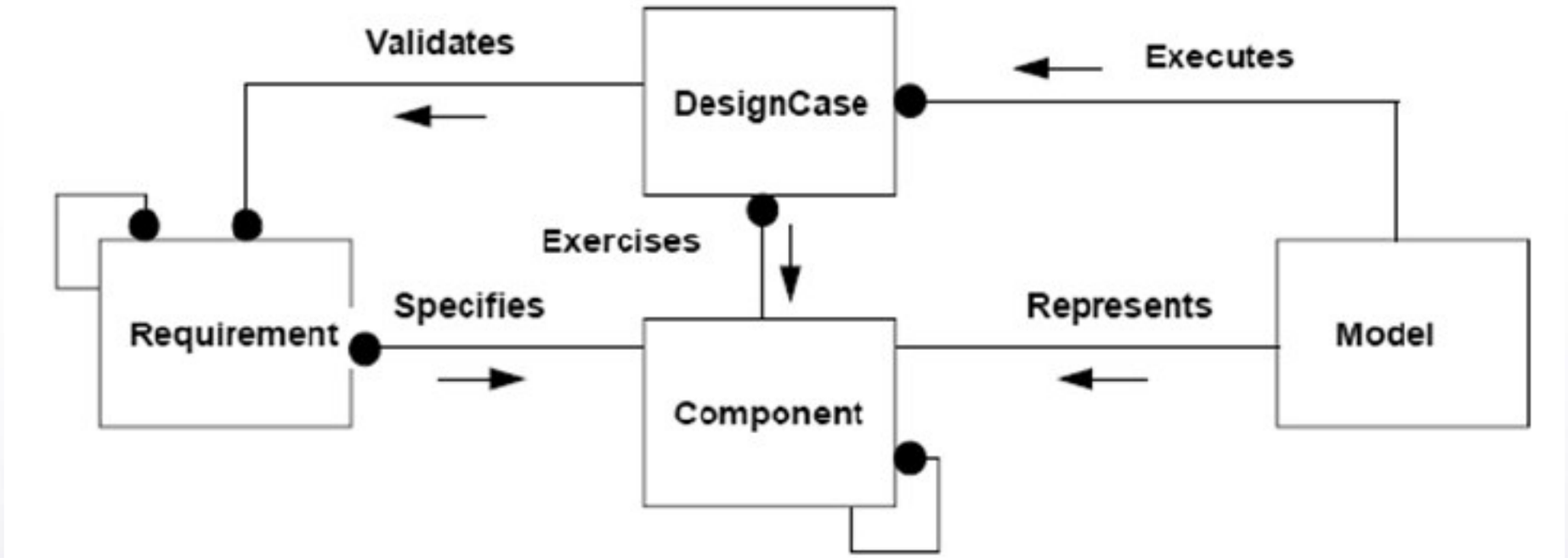
General Process:
All Methodologies shows
EMPHASIS (not waterfall tasks)






Develop Requirments
Make technology, design decisions & identify alternatives
Formulate models
Build test articles
Test articles
Validate models against data and analysis
Analyse test and existing data
Assess compliance with requirements

MDSE - Model Driven System Design



Fundamentação matemática para o MBSE

A. Wayne Waymore (T3SD)

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.

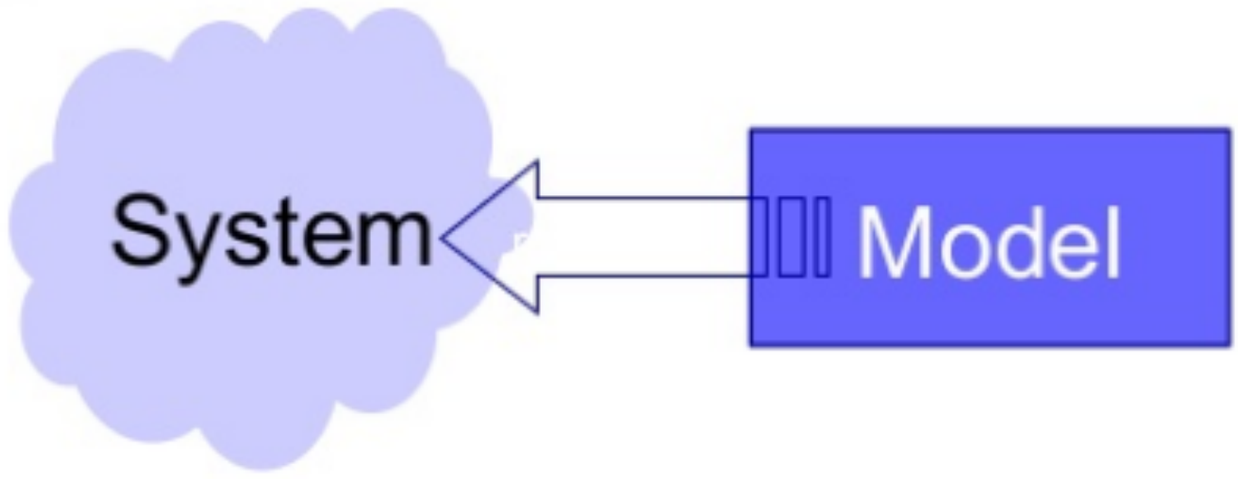
Wymore, A. Wayne, “Contributions to the Mathematical Foundations of Systems Science and Systems Engineering,” Systems Movement: Autobiographical Retrospectives, The University of Arizona, Tucson, AZ, 2004.

Tuning Back Design and System Design

Even if we agree that system design should be model driven, there are also several approaches to proceed with such modeling design e to couple with the previous subject developed during this course.

Models

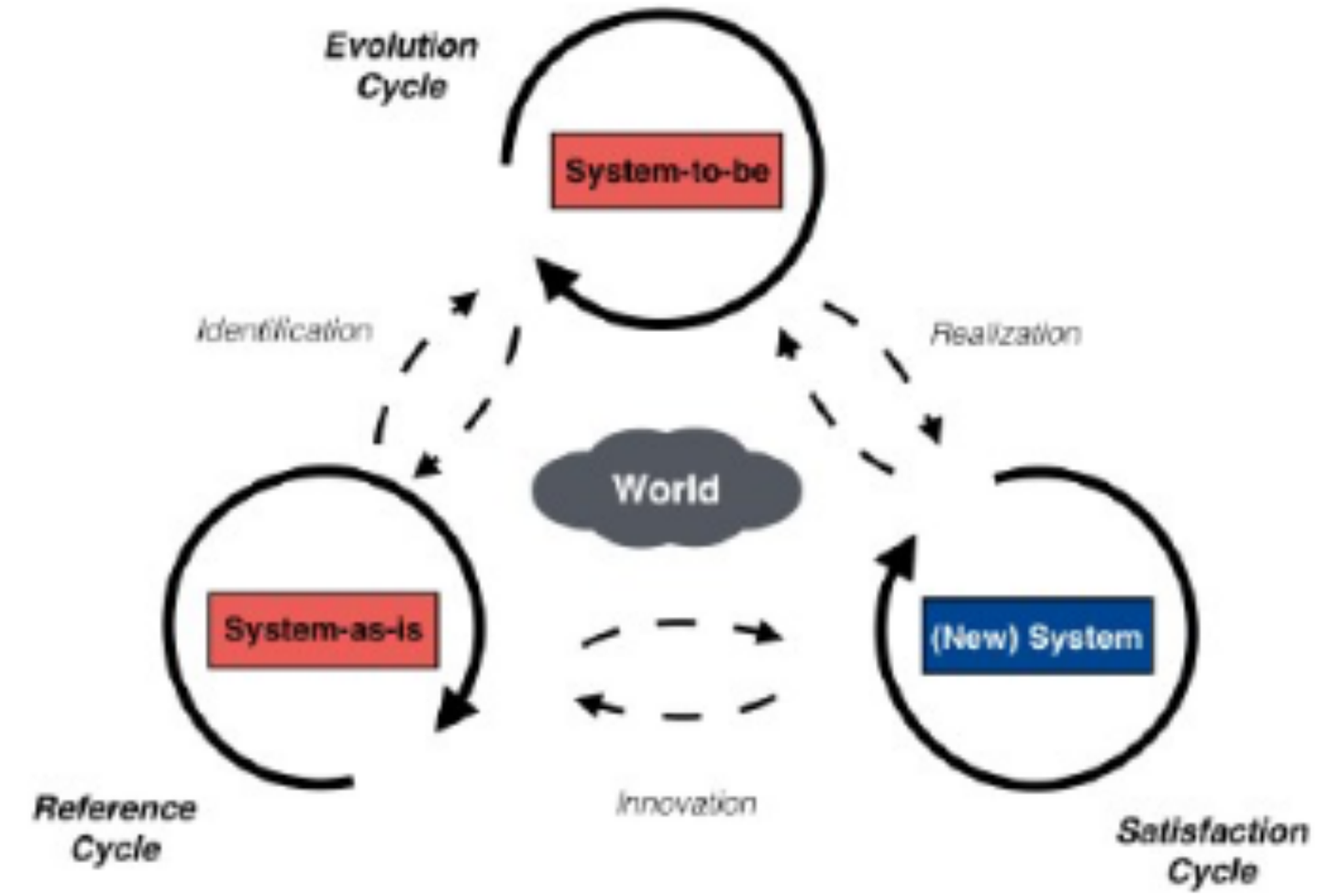
What is a model?



Mapping Feature	A model is based on an original (=system)
Reduction Feature	A model only reflects a (relevant) selection of the original's properties
Pragmatic Feature	A model needs to be usable in place of an original with respect to some purpose

Purposes:

- descriptive purposes
- prescriptive purposes


Evolution
Cycle
System-to-be
Identification
Realization
World
System-as-is
(New) System
Reference
Cycle
Innovation
Satisfaction
Cycle

Standard Methods

Model Based: Z, B, SysML, PtN, Object PtN, …

Algegraic: ACT-ONE, Process Algebra,…

Extended Logic: LTL, CTL, …

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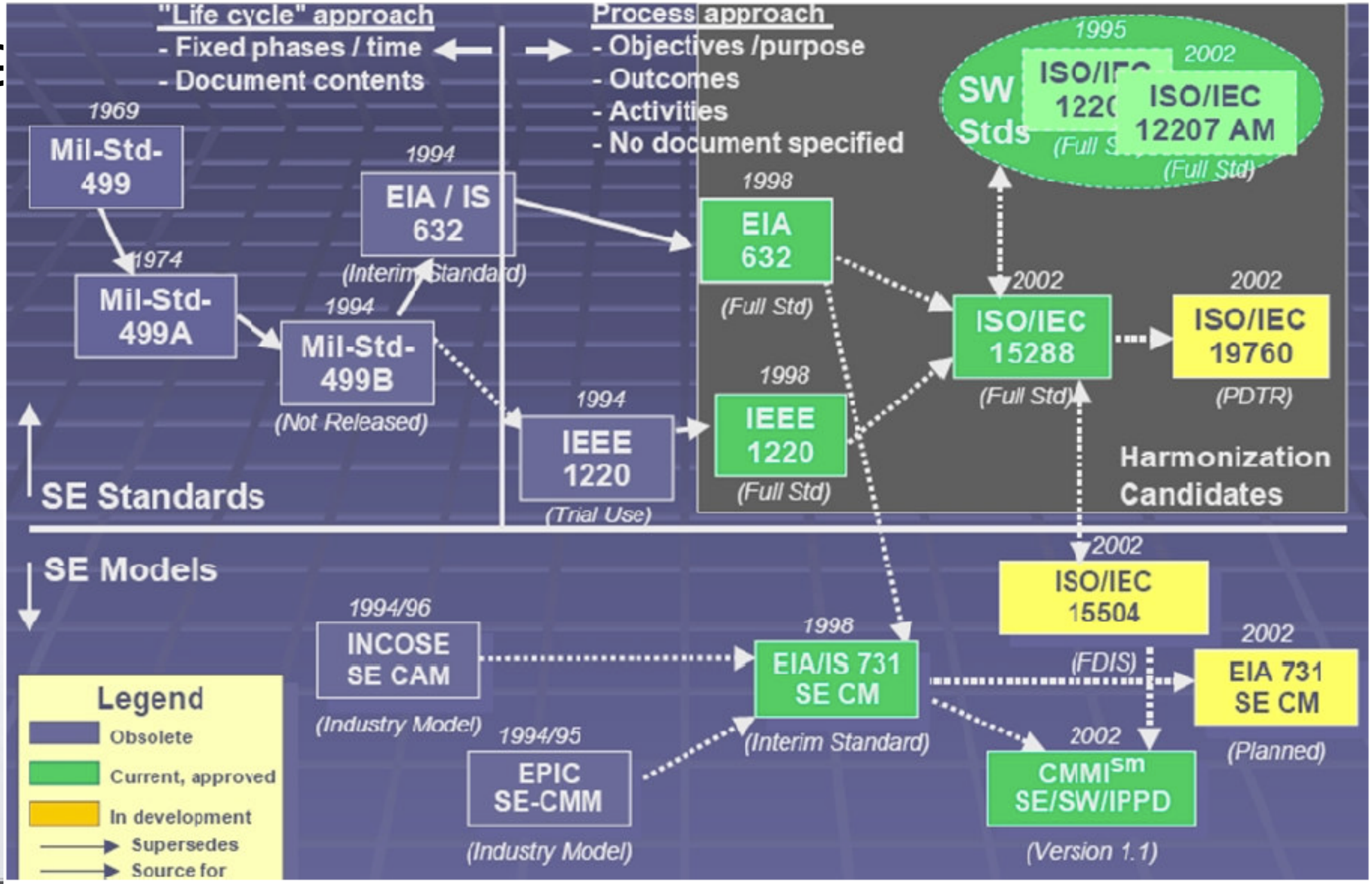
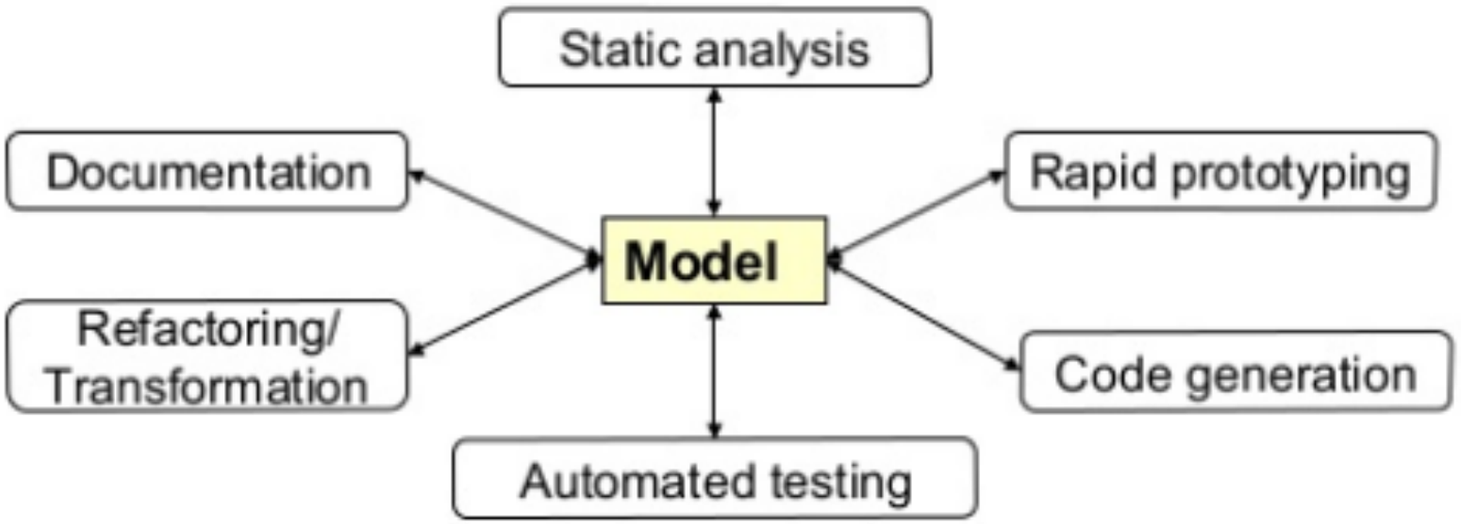

"Life cycle" approach
- Fixed phases / time
- Document contents
Process approach
- Objectives /purpose
- Outcomes
- Activities
- No document specified
1969
Mil-Std-499
1974
Mil-Std-499A
1994
Mil-Std-499B
(Not Released)
1994
EIA / IS 632
(Interim Standard)
1994
IEEE 1220
(Trial Use)
1998
EIA 632
(Full Std)
1998
IEEE 1220
(Full Std)
1995
2002
SW Stds
ISO/IEC 12207 AM
(Full Std)
2002
ISO/IEC 15288
(Full Std)
2002
ISO/IEC 19760
(PDTR)
Harmonization Candidates
SE Standards
SE Models
1994/96
INCOSE SE CAM
(Industry Model)
1994/95
EPIC SE-CMM
(Industry Model)
1998
EIA/IS 731 SE CM
(Interim Standard)
2002
ISO/IEC 15504
(FDIS)
2002
EIA 731 SE CM
(Planned)
2002
CMMI sm SE/SW/IPPD
(Version 1.1)
Legend
Obsolete
Current, approved
In development
Supersedes
Source for



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

Objetivos do Curso

A proposta básica do curso era justamente para diferenciar o projeto de sistemas comparado ao processo de projeto mais intuitivo e familiar que é direcionado a produto.

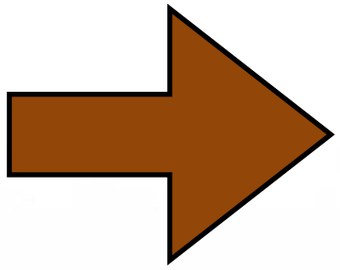
O projeto orientado a "produtos"

O projeto orientado a "produtos" é eminentemente funcional, ainda quando o resultado não é de fato um produto mas um software. O que importa de fato não é a natureza do artefato final mas a constituição de um processo de projeto "product-oriented" que originou de fato termos como a "fábrica de software". Portanto trata-se de dar "vida" a um objeto (ou a um artefato conceitualmente tratado como tal) cuja existência própria gera uma mudança no ambiente por sua capacidade de própria de interferência.

A mudança de paradigma

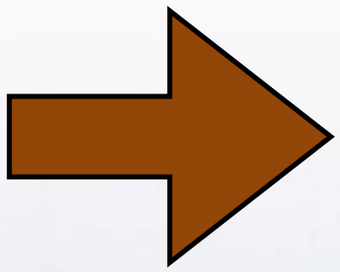
produto

sistema



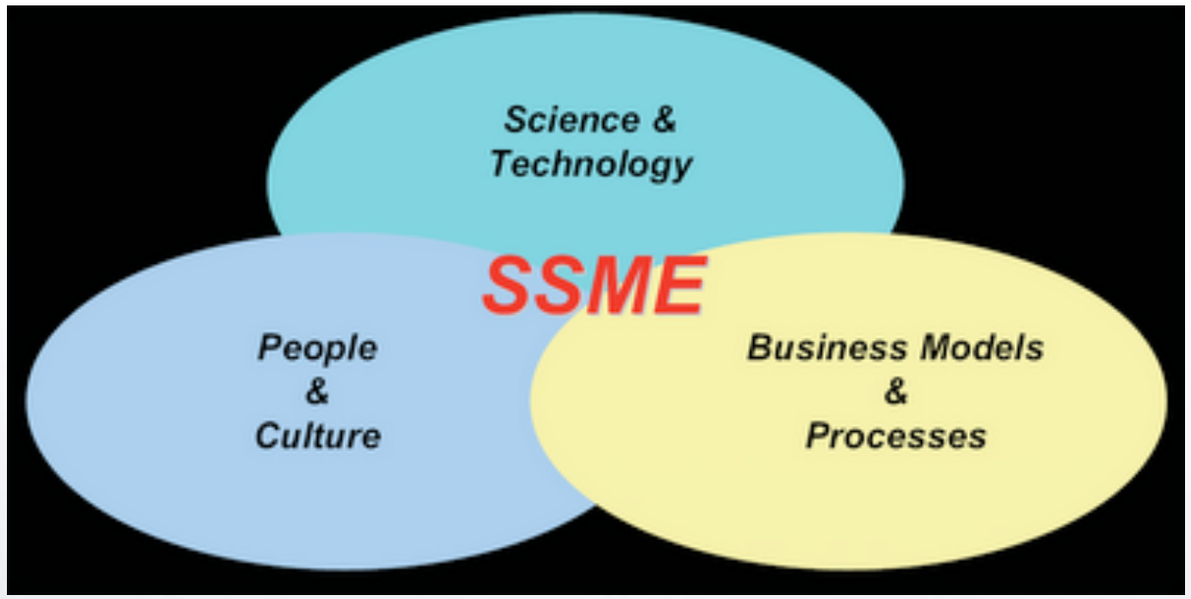
mesmo desenvolvimento orientado a produto

produto & systema



opção por um desenvolvimento orientado a modelos

Service Science, Management and Engineering



SSME is a new research field that aims to formalize and control the relationship between humans and (cognitive) information systems to establish a new paradigm of associative interaction.

Obrigado

Reinaldo