Software Requirements Engineering: Exploring the Role in Simulation Model Development

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Research Objective

The Question:

Do Modeling and Simulation (M&S) studies employ Software Requirements Engineering (SRE), implicitly or explicitly, in the model development process?

- What are the SRE activities?
- To what extent are they found in M&S model development methodologies?
- What changes might ensue from an increased use of SRE in M&S model development?

Presentation Outline
In Question Format

- Why is SRE of importance to individual M&S projects or to the community in general?
- What constitutes SRE?
- What is the current role of requirements in Modeling and Simulation?
- In what way can SRE activities be introduced into the M&S process to improve model credibility?

Why is SRE of importance to individual M&S projects or to the community in general?

Co-Dependencies: The Early Years

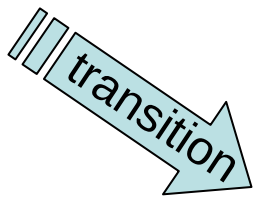
- M&S influence on Software Engineering
  - Code Reuse: Tocher's GSP (1958)
  - ADTs and OO: Simula '67(1967)
- Software Engineering influence on M&S
  - Adoption of programming language constructs
  - Inclusion of graphical interfaces
  - External access compilers

Co-Dependencies: The Evolutionary Years

- Software Engineering influence on M&S
  - Fostered movement toward the more *concrete* implementation arena
    - Production of executable simulation models
    - SPL variants of GPSS, Simula, GASP
- M&S influence on Software Engineering
  - Fostered the expanded use of *abstractions* in defining software systems
    - Emergence of models and modeling
    - Model Driven Development

Requirements Engineering: The Next Domain of Exchange

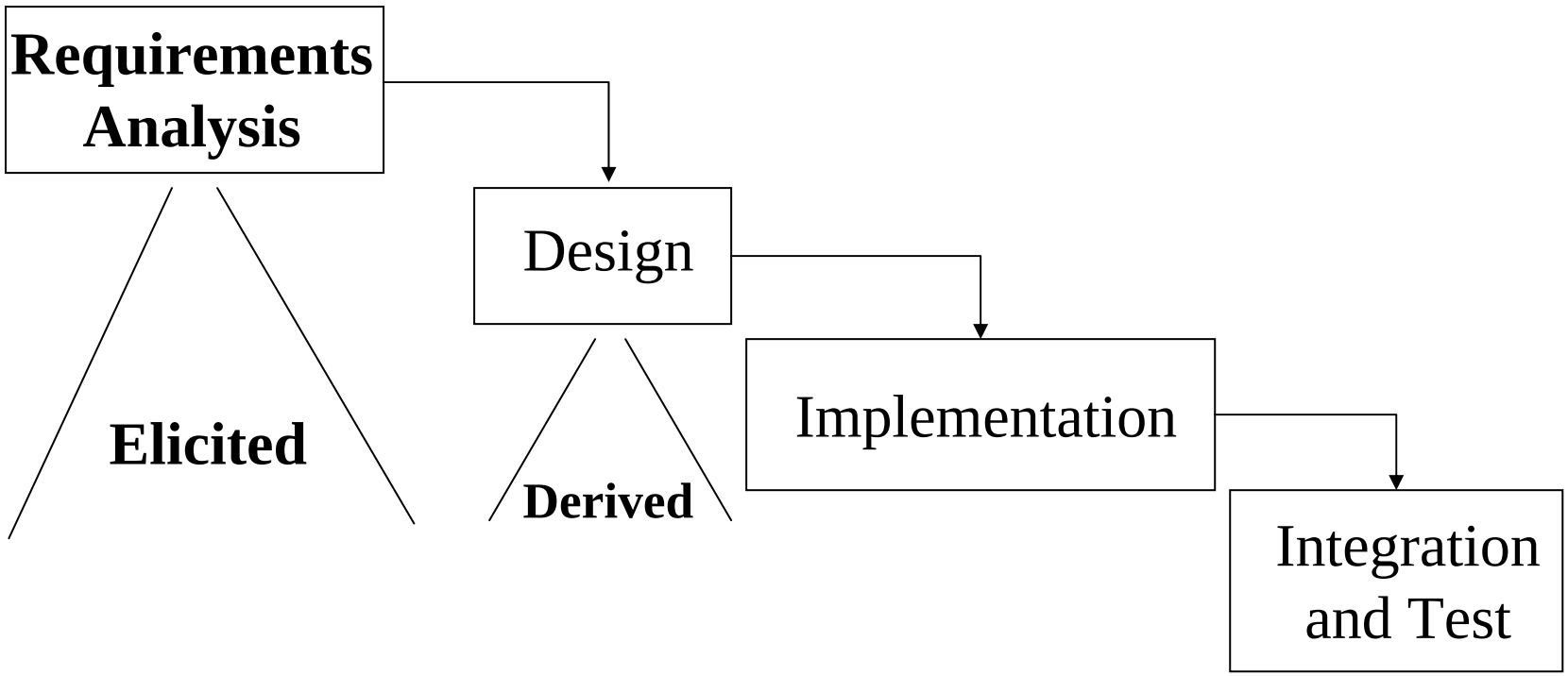
- Software Requirements Engineering
  - 10 years of R & D
  - Well-defined (but still evolving) processes and activities
  - Supporting methods and techniques



M&S Model Development

What constitutes SRE?

The “Classical” Software Development Process

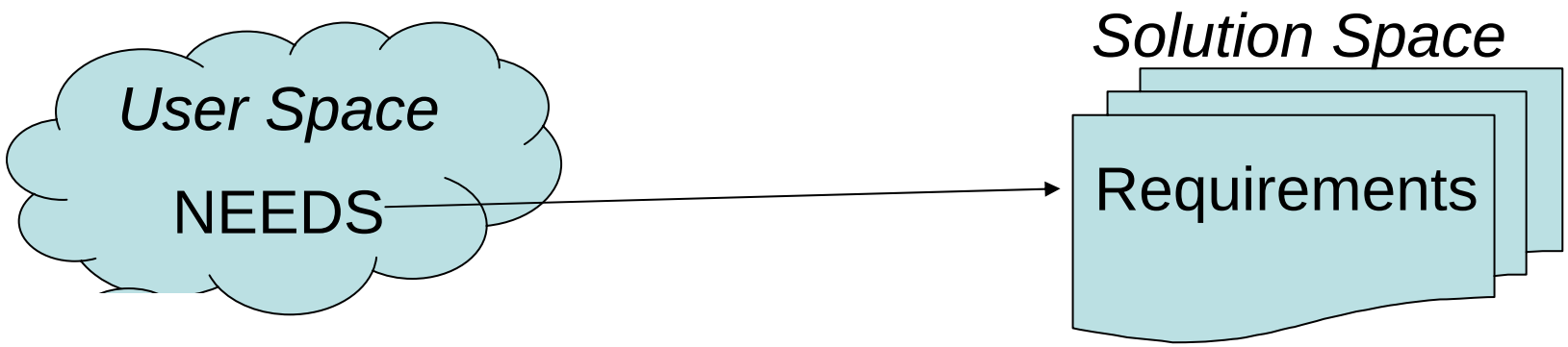


The Waterfall Model

What Is A Requirement

- Webster
  - Something required; something wanted or needed

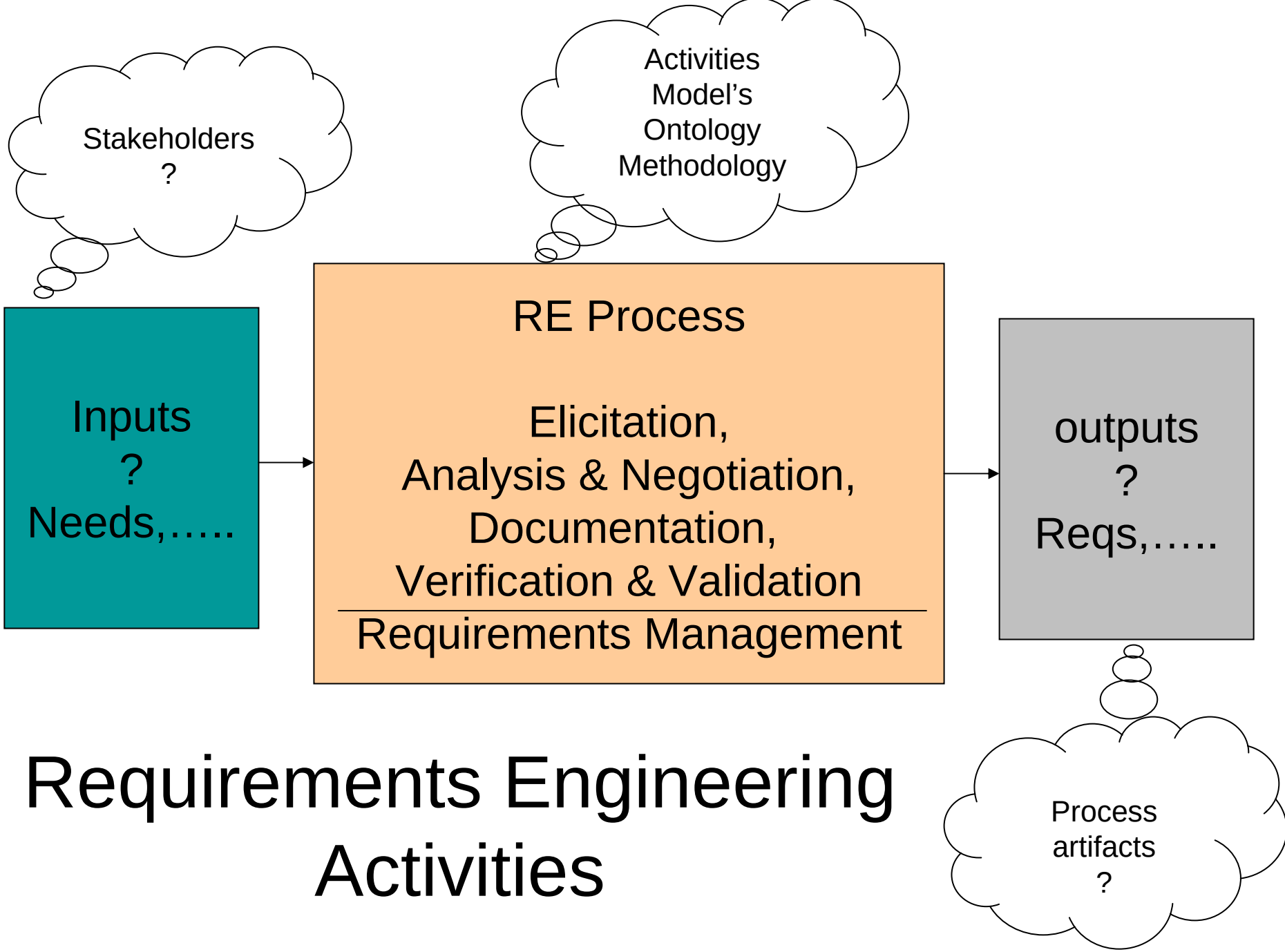
- IEEE 1012
  - A condition or capability needed by a user to solve a problem or achieve an objective
  - A condition or capability that must be met or possessed by a system… to satisfy a contract standard, specification, or other formally imposed document



What is Requirements Engineering?

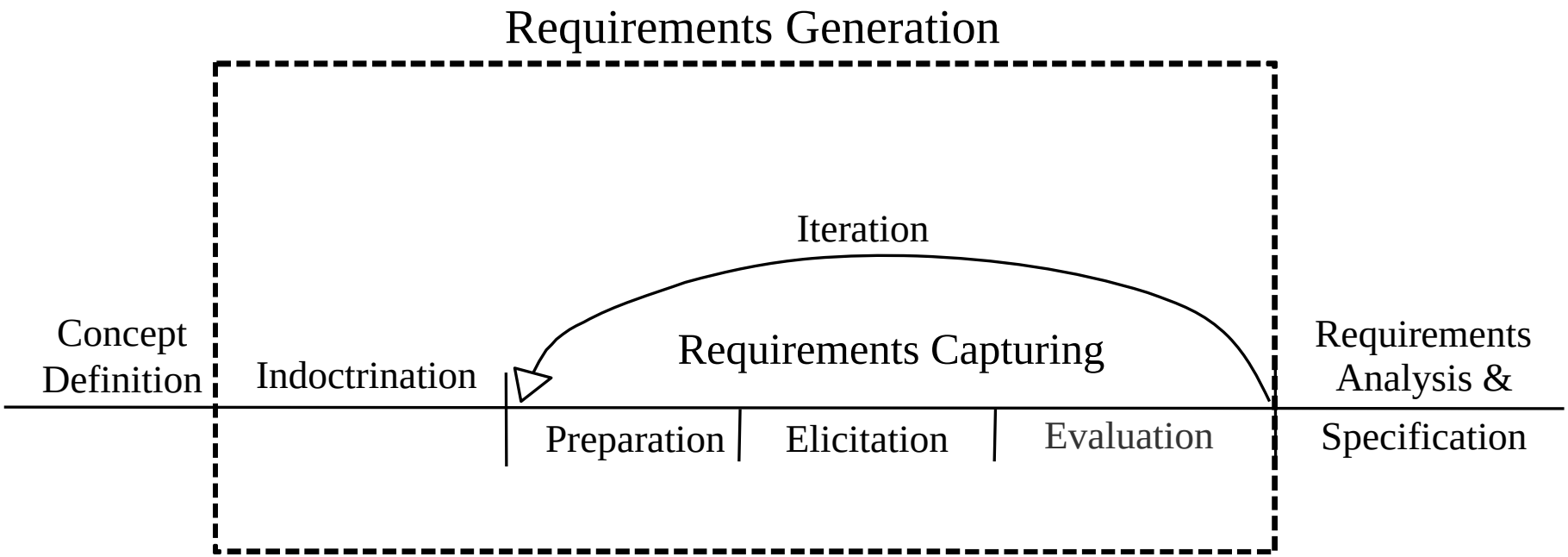
- Requirements Engineering can be defined as the systematic process of developing requirements through an *iterative* co-operative process of
  - analyzing the problem,
  - documenting the resulting observations in a variety of *representation formats*, and
  - checking the *accuracy of the understanding* gained.

[Macaulay 96, *Requirements Engineering*, Springer-Verlag Limited, 1996]



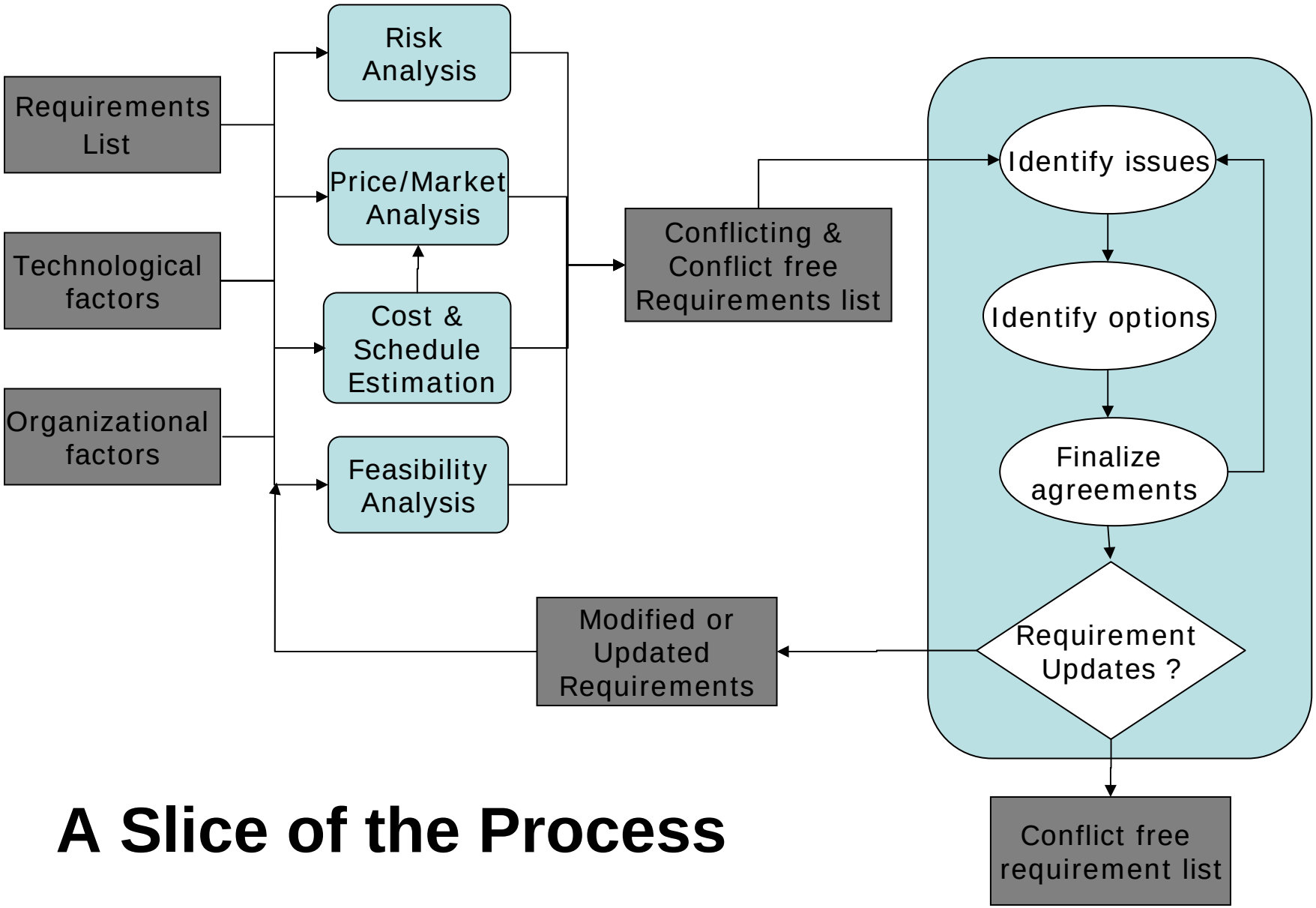
Requirements Engineering Activities

The Requirements Generation Model (RGM)
A Macro View



Bring into focus the distinct components and their role within requirements generation

Requirements Triage



A Slice of the Process

RE: Points of Emphasis

- Elicitation and analysis are prominent activities in RE models
- Need for Risk analysis is acknowledged
- Scope often extends beyond RE
  - Architecture, design implementation
    - Agile and Win-Win models
- Diverse set of Models
  - RGM: interactive + monitoring methodology
  - Knowledge Level Process Model: well-defined process structure
  - Agile: rich set of principles, flexible process

What is the current role of requirements in Modeling and Simulation?

Perception of RE in M&S

Requirements phase and its importance not reflected in M&S process descriptions

- Paucity of treatment of requirements specification in textbooks
- Lack of RE identification in M&S Models
- Relative lack of attention given to RE in M&S literature
  - Exception: Military Applications

Treatment of Requirements Identification in M&S Textbooks

- Early Textbooks: Mize & Cox
  - Described M&S phases in general terms
    - Formulate Problem, construct mathematical model, derive solution, test model and solution, establish controls and implement
  - Student / lecture orientation might have minimized importance of M&S models
    - Not essential to learning the subject

Treatment of Requirements Identification in M&S Textbooks

- The next 3 decades
  - Emphasized simulation languages and environments
  - Little real treatment of requirement-related topics, e.g.
    - Model requirements, requirements specifications and simulation requirements
- More current M&S books (2000 – 2006)
  - Continue to give little or no attention to model requirements…..
- Exception: Robinson

  Simulation: The Practice of Model Development and Use
  - Emphasizes importance of the conceptual modeling phase
  - Identifies 4 main requirements of conceptual modeling
    - Accuracy, credibility, utility and feasibility
  - Describes product of Conceptual Modeling Phase as a *simulation project specification*

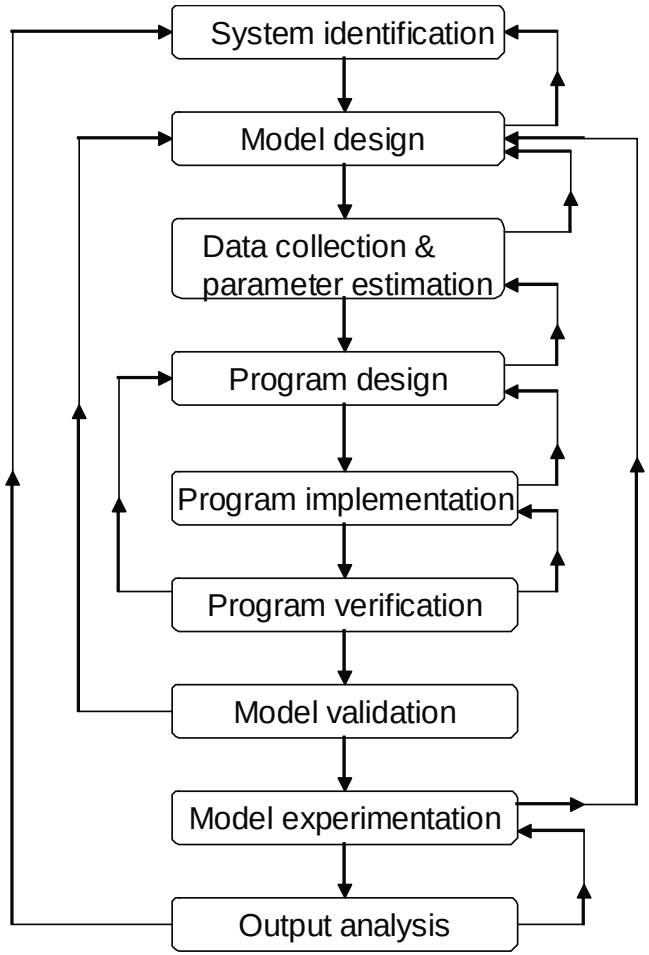
Treatment of Requirements in Military and Government Studies

- Contemporary applications of M&S
  - "Contract driven" process
  - Concern for test criteria to support acceptance decisions

  Collectively, emphasized the need for and presence of requirement specifications

- Notable Applications:
  - Global Systems Simulation Program
  - Waste Treatment

Treatment of Requirements in M&S Life-Cycle Models



THE KREUTZER MODEL

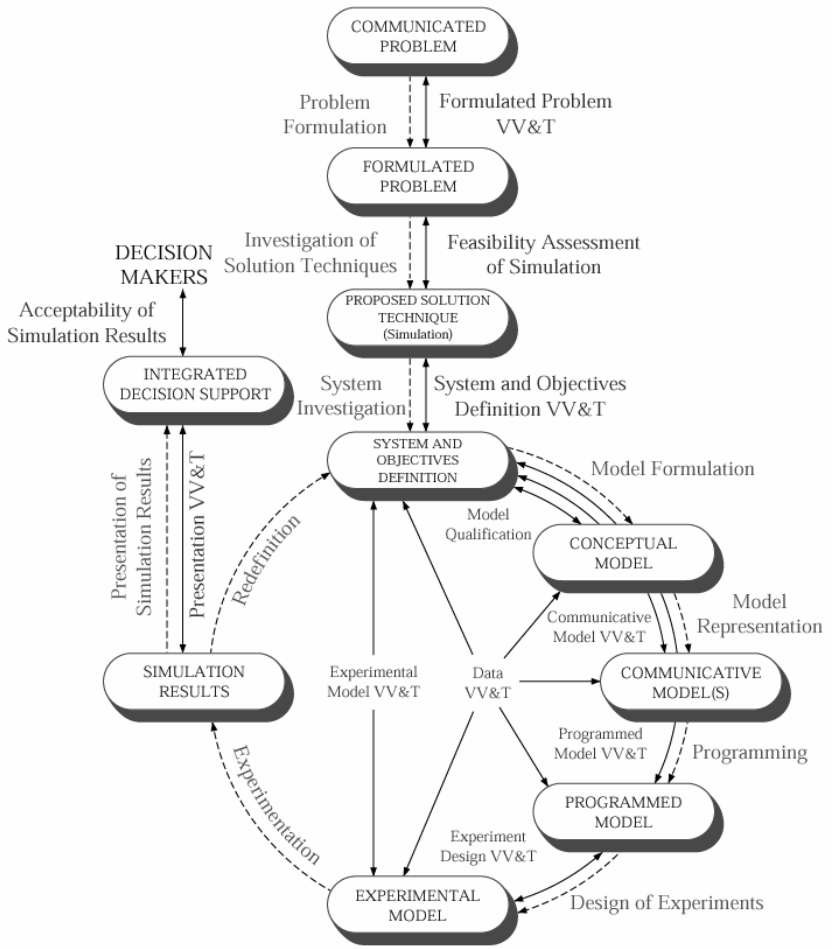
- Emphasizes activities and information flow
- Focuses on “modeling style and programming techniques”
- Shares perspectives on conceptual understanding and notations used to represent such

But

- No evidence of explicit references to:

  Model requirements, requirements specifications, etc.

Treatment of Requirements in M&S Life-Cycle Models



THE BALCI-NANCE MODEL

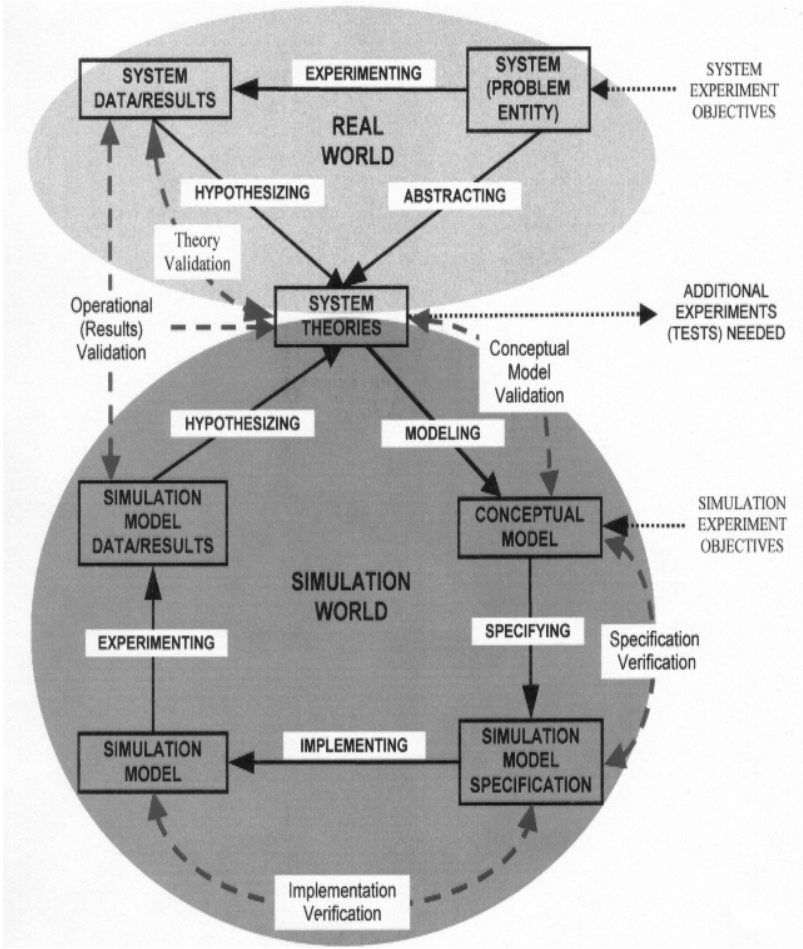
- Enunciates 3 groupings of phases
  - Problem Formulation,
  - Model Development, and
  - Integrated Decision Support
- Problem Formulation:

  Transforming *communicated* problem into a *formulated* problem
  - Prescribed actions herein might include some elements of SRE
  - Mentions requirements in references to satisfying simulation project provisions

However

- No explicit guidance given for developing, analyzing or using such requirements

Treatment of Requirements in M&S Life-Cycle Models



THE SARGENT MODEL

- Characterizes evolving relationship between simulation model and continually changing complex system
- Permits questions to be formulated in terms of system experiment objectives
- Employs system theories, *conceptual modeling* and operational results to validate simulation model behavior

However

- Description of activities omit details of specifying model requirements

In what way can SRE activities be introduced into the M&S process to improve model credibility?

Increasing RE Potential in M&S Modeling Activities

- Address division (barrier) between Modeling and Programming
  - SRE: Model Driven Development, RAD
  - M&S: SysML
- Introduce appropriate levels of details in modeling that explicitly reference RE activities
  - Problem Definition (Balci-Nance Model)
  - Conceptual and Communicative Modeling (Balci-Nance and Sargent Models)

QUESTIONS?