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Need for and Structure of an M&S Body of Knowledge

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MESSAGE (1/2)

Simulation offers a very rich paradigm

1. to **perform experiments** with dynamic models &
2. to **provide experience** either
   - 2.1 for **entertainment** or
   - 2.2 to **develop/enhance** three types of **skill**, i.e., motor skills, decision making skills, & operational skills.

- Lack of an explicit consensus of an M&S Body-of-Knowledge inhibits its evolution.

MESSAGE (2/2)

- Having M&S acknowledged as a distinct branch of knowledge is important in **advancing the profession, industry and marketplace**.
- A **concerted effort** will ensure that M&S as a profession evolves in a timely manner.
- This will **enhance its usefulness** in many complex problems.

OUTLINE

I. INTRODUCTION

II. BOK *TECHNICAL CONCEPTS*

III. M&S BOK *CONTENT*

IV. M&S BOK *EVOLUTION*

V. CONCLUSION

INTRODUCTION

1. Thesis

2. Context / Circumstances
   a. **Diversity M&S Practice**
   b. Comprehensive Scope of M&S

3. Stakeholder Needs / Opportunities

Thesis

- Specifying the information that constitutes the M&S body of knowledge is:
  - essential to *relating M&S to science and technology*
  - paramount in *establishing the identity of M&S* as a distinctive discipline

- Having M&S acknowledged as a distinct branch of knowledge is important in *advancing the recognition* of the **profession, industry and marketplace**.

- *A concerted effort is needed* to ensure that M&S as a profession evolves in a timely manner.

Thesis - Lemma

- M&S technology, profession, industry and market are evolving
- Lack of an explicit consensus M&S Body-of-Knowledge inhibits this evolution
- Broad-based collaboration to specify the M&S BOK is desired, and feasible
- An open-source program of activity can serve to achieve the objective BOK commensurate with stakeholder needs and interests particularly in M&S workforce development (e.g. BOK, curricular management, professional certification, etc.)
- Socialization of the topic across organizational constituencies and agendas is underway … Prototyping is about to begin

Your interest, participation, and influence will make a difference

This is (literally) the BOTTOM LINE

INTRODUCTION

1. Thesis

2. Context / Circumstances
   a. Diversity M&S Practice (*M&S 101*)
   b. Comprehensive Scope of M&S

3. Stakeholder Needs / Opportunities

Comprehensive Scope of M&S:

Ören, T.I. (2007). The Importance of a Comprehensive and Integrative View of Modeling and Simulation. Proceedings of the Summer Simulation Conference. San Diego, CA, July 15-18, 2007.

Aims & importance :

- Explore different **perceptions** of M&S studies
- *Present them **in a unified framework***
- Underline **advantages of each perception**

- Hence, **benefit from the rich paradigms** M&S provide

Possible perceptions of M&S studies

(**Each perspective discriminate different types of simulation & has pragmatic consequences**)

1. Purpose of use
2. Problem to be solved
3. Connectivity of operations of simulation and real system
4. Types of knowledge processing
5. Philosophy of science

According to Type of Knowledge Processing

Simulation is perceived as:

Computational activity (process)

Systemic *activity* *(since 1960s)*

Model-based *activity* *(since 1970s)*

Knowledge generation activity

Knowledge processing activity

Possible Stakeholders of M&SBOK:

Stakeholder	Possible uses
- Novice	- Explore the discipline - Determine applicability
- Practitioner	- Expansion of knowledge - Specific problem solving - Identification and evaluation of techniques
- Learner	- Expansion of knowledge - Verification of derived knowledge - Accomplishment of corporate or certificate requirements

Possible Stakeholders of M&SBOK:

Stakeholder	Possible uses
- Academia	- Referencing - Expansion of knowledge - Curriculum/course development (including degree programs, academic/professional development courses)
- Industry	- Marketing - Offering professional courses - Personal selection/training - Technical investment

Possible Stakeholders of M&SBOK:

Stakeholder	Possible uses
- Funding Agencies	- Determine priorities
- Acquirer/User of Product/Service	- Source selection - Evaluation of products, services, techniques, vendors/providers
- Market	- Formation of market, niche markets, and workforce
- Policy Makers (National, International)	- Set policies for the country/countries/region(s) to benefit from M&S

Possible Stakeholders of M&SBOK:

Stakeholder	Possible uses
- Professional Societies*	- Guidance - Serve the members properly

* 80 Civilian M&S Societies

and 25 Defense M&S Groups are listed at :

http://www.site.uottawa.ca/~oren/links-MS-AG.htm

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BOK Definition

Body of Knowledge is:

- "Structured knowledge that is used by members of a discipline to guide their practice or work."
- "The prescribed aggregation of knowledge in a particular area an individual is expected to have mastered to be *considered* or *certified as a practitioner*."

BOK for M&S

- "The Body-of-Knowledge for M&S (M&S BOK) is the domain of knowledge (information) and capability (competency) that serves to provide identity to the M&S community-of-practice … and subsequently the M&S profession, industry, and market. "

- "A pragmatic view is that: "M&S BOK is a stepping stone *to unifying the M&S community.*"

BOK as *Content* versus BOK as *Index*

- The content of the BOK is knowledge-information.

- BOK guide is an index to the BOK contents and their relationships - The *index* of a BOK is a set of pointers providing ‘handles’ whereby the subject information content may be denoted, identified, accessed and manipulated.

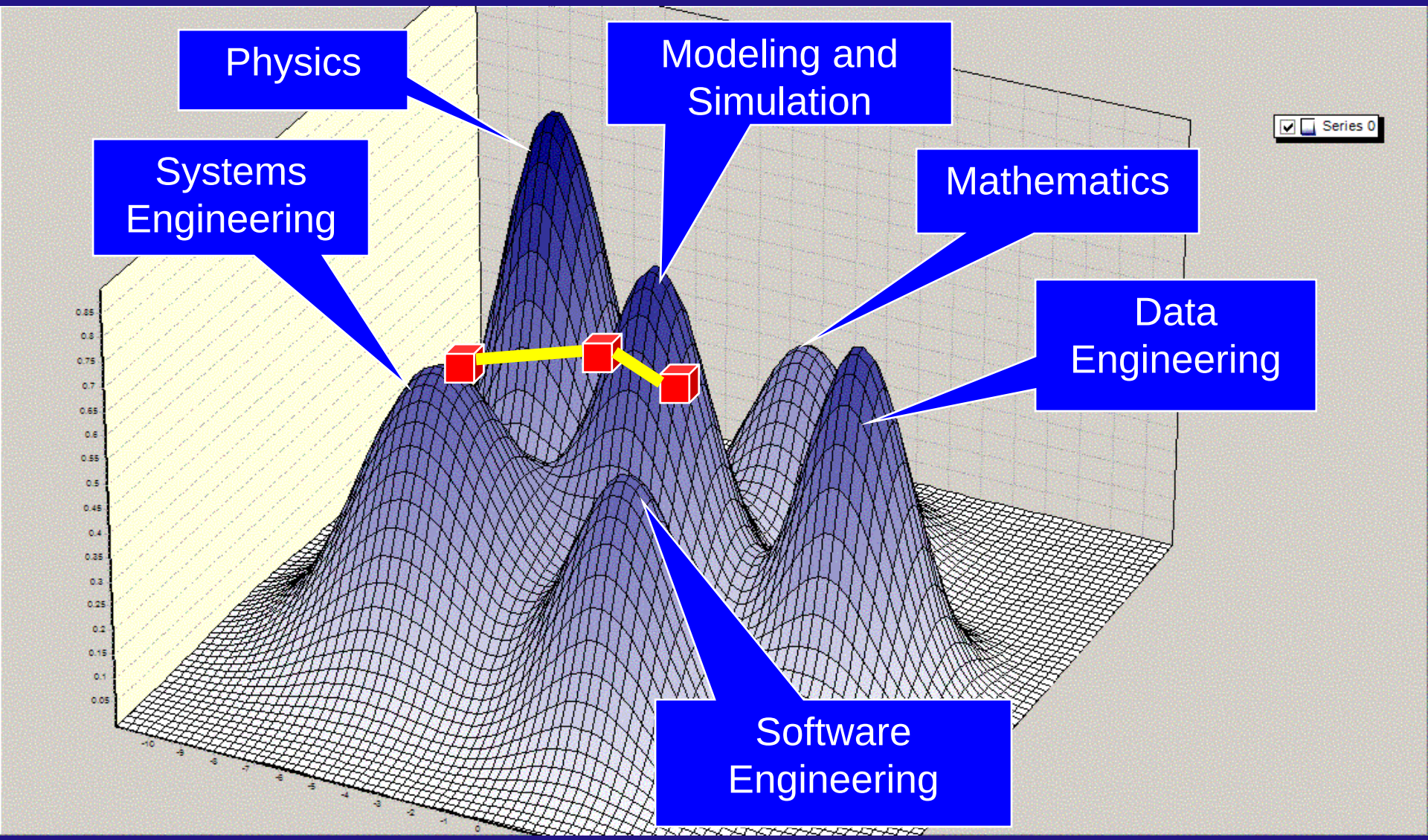
- Overloading terminology is common – context provides semantic discrimination.

BOK Attributes

- Include identification of :
  - *elements* of the M&S BOK and
  - *relationships*
    - among elements of M&S BOK and
    - between elements of M&S BOK and other BOKs

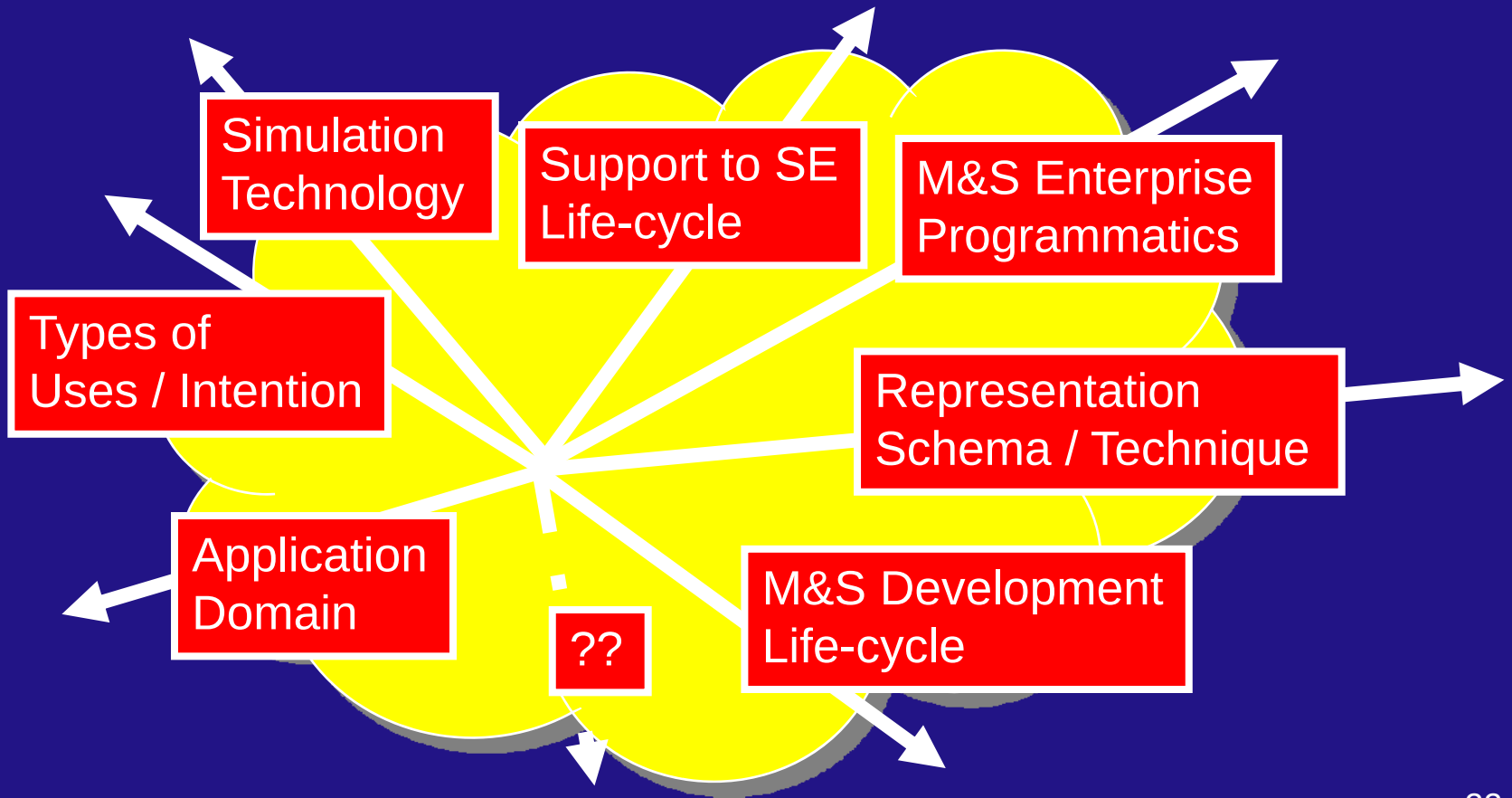
- Are Authoritative
- Are Comprehensive
- Are Discriminative
- Are Useful
- …

Simplified Knowledge Manifold Classification and Relationships



M&S Body of Knowledge Manifold

- The ‘basis vectors’ of the M&S BOK also admit *both* discovery and invention:



Knowledge Designation (1)

- **Knowledge** - The nature of 'knowledge' and 'competency' are that informed-action is intentionally (and successfully) conducted upon a target artifact.

- **Knowledge to topic** - Knowledge elements that are manifest as 'topics' are related to the spirit of body-of-knowledge in that one or another knowledge (topical) element is employed as a competency to affect or operate-on (as a direct-object-entity) another element in order to achieve intended consequences. In this spirit, many terms both in the lexicon and the knowledge (topical) element are nouns or adjective-modified nouns or verbs.

- **Knowledge Elements** - Knowledge elements (as originally entered) may be members of any of the three (behavioral-knowledge, object, intention)

Knowledge Designation (2)

- **Information segregation** - The need is to put knowledge ‘terminology’ one place and component ‘knowledge elements’ someplace else (or alternatively to provide the capability to (auto-)generate these composites)

- **Construction** - Given verbals for competency / knowledge (e.g. build, employ, use, analyze, develop, etc.) ; noun object entities (simulation, conceptual model, data, program plan, etc.); and direct-object intentions or consequences - generate declarative sentences or rules that constitute elements of the M&S Body of Knowledge. For instance: “ ‘develop’ ‘simulations’ for ‘use in analysis’ “, or “ ‘execute’ ‘FEDEP’ for HLA Federation’”, …

Knowledge (Information) Management

- Insofar as BOK is a knowledge or information domain, knowledge / information management practices pertain :
  - Identification
  - Designation
  - Classification
  - Relation
  - Generation
  - Storage
  - Retrieval

Knowledge Element Explication (1)

- **Knowledge-Element Denotation:** What is the name of the Knowledge Element, i.e. its denotative 'handle'?
- **Semantic Content of Knowledge-Element:** What does it mean? e.g. a paraphrase of what knowledge is contained therein
- **Significance / Utility of the Knowledge-Element:** Why's it important? What benefit derives from the existence of the Knowledge-Element? What risk or pejorative result may result from is absence?
- **Roles associated with the Knowledge-Element:** Who cares about this particular Knowledge-Element? E.g. developer, custodian, user, etc.

Knowledge Element Explication (2)

- **Relationship to elements of practice or behavior within the M&S community of practice:** How is this Knowledge-Element related to what members of the M&S community of practice do?

- **Relationships to other Knowledge-Elements within the M&S BOK:** How is this Knowledge element related to others in the M&S BOK? e.g. is-a-kind-of, is-a-part-of, precedence, etc.

- **Relationships to other Knowledge-Elements outside the M&S BOK:** How is this Knowledge element related to others in the M&S BOK? as, for instance those associated with other domains of knowledge / arts / sciences: mathematics, physics, business, etc.

Define knowledge via BNF

BOK Statement ::= <verbal> (operating on)
<object-entity> (for intention of)
<intention or consequence>

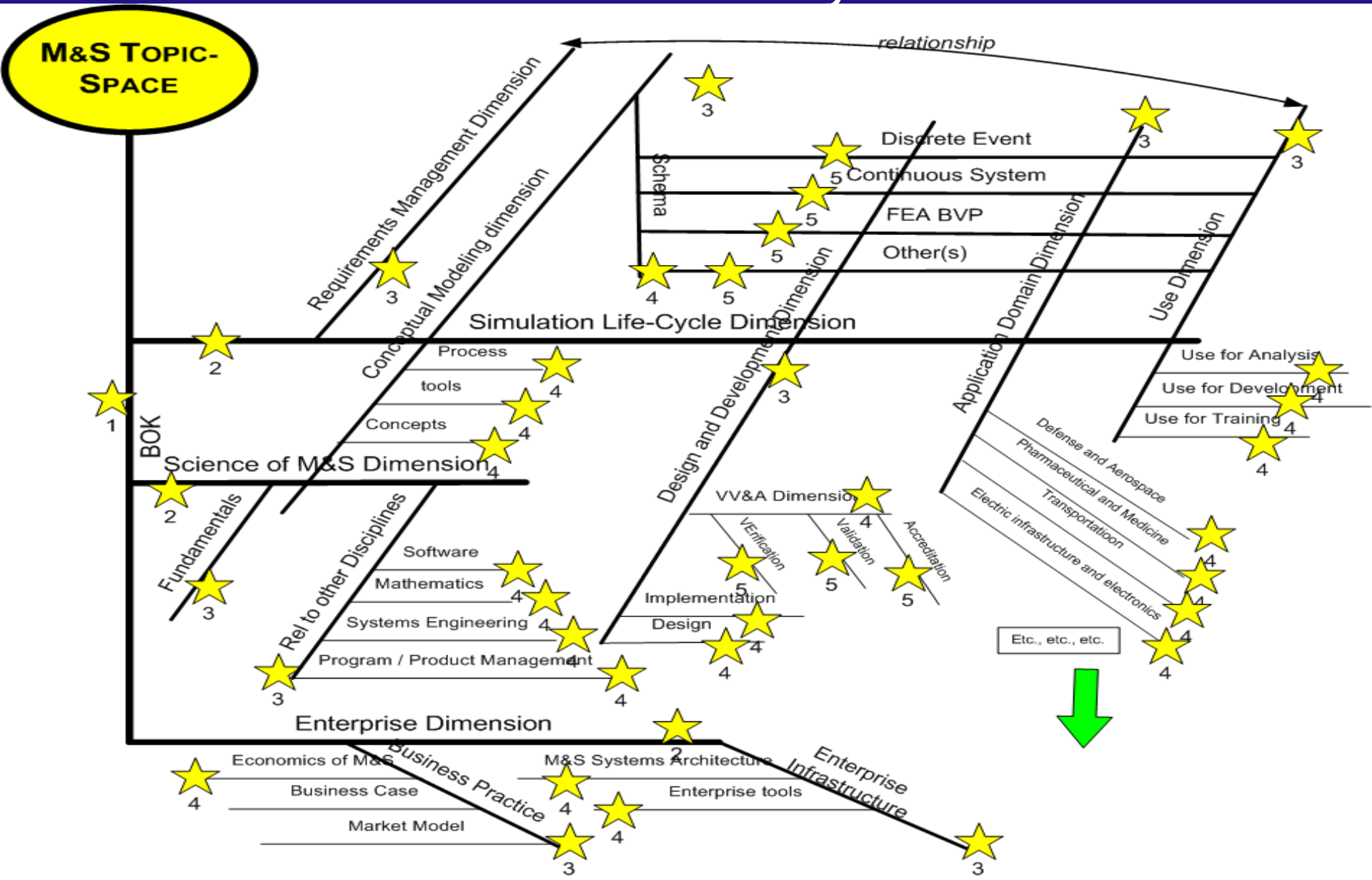
“ “ - literals
xxx_xxxxx - syntactic categories
::= - defintions
[ ] - optionals
| - or, alternatives
{ } - repeat zero or more times

A Survey on Ontology Tools

OntoWeb Ontology-based information exchange for knowledge management and electronic commerce.
IST-2000-29243
Date: May 31, 2002

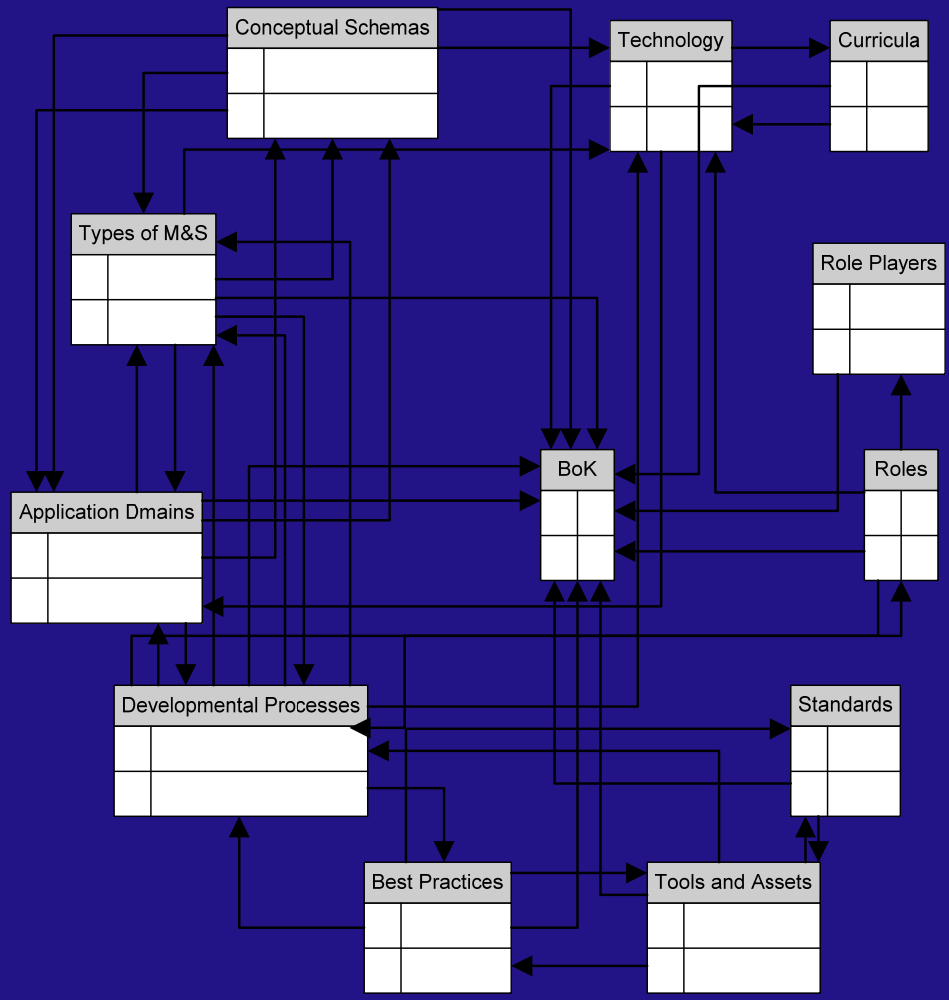
http://www.aifb.uni-karlsruhe.de/WBS/ysu/publications/OntoWeb_Del_1-3.pdf

Tree-Structured, Hyperlinked Taxonomy



Relational Taxonomy

Notional, admittedly, … but not more complex than may be necessary



OUTLINE

I. INTRODUCTION

II. BOK TECHNICAL CONCEPTS

III. M&S BOK CONTENT

- Three Aspects of Professionalism
- Supporting Domains of M&S
- Core Areas of M&S

IV. M&S BOK EVOLUTION

V. CONCLUSION

3 Aspects of Professionalism in M&S (1)

1. Knowledge

   To solve problems, i.e., knowledge of

   - Application area(s)
   - Supporting domains
   - M&S core

   To guide attitude in problem solving

   - Code of professional ethics

3 Aspects of Professionalism in M&S (2)

2. Professional activities
   - Knowledge generation and dissemination (Academia, R&D)
   - Application (generation of products/services) (Industry)

3. Professional maturity/conduct
   - Professional and ethical conduct
   - Certification of professionalism

M&SBOK - Supporting Domains

Science

- Systems science
- Physics
- Differential equations
- Numerical analysis
- Probability
- Statistics
- Queuing theory
- Computer Science
- Artificial Intelligence
- Software agents

Engineering

- Systems engineering
- Software engineering

Management

- Enterprise mgmt
- Project mgmt
- Product mgmt

Systems Engineering

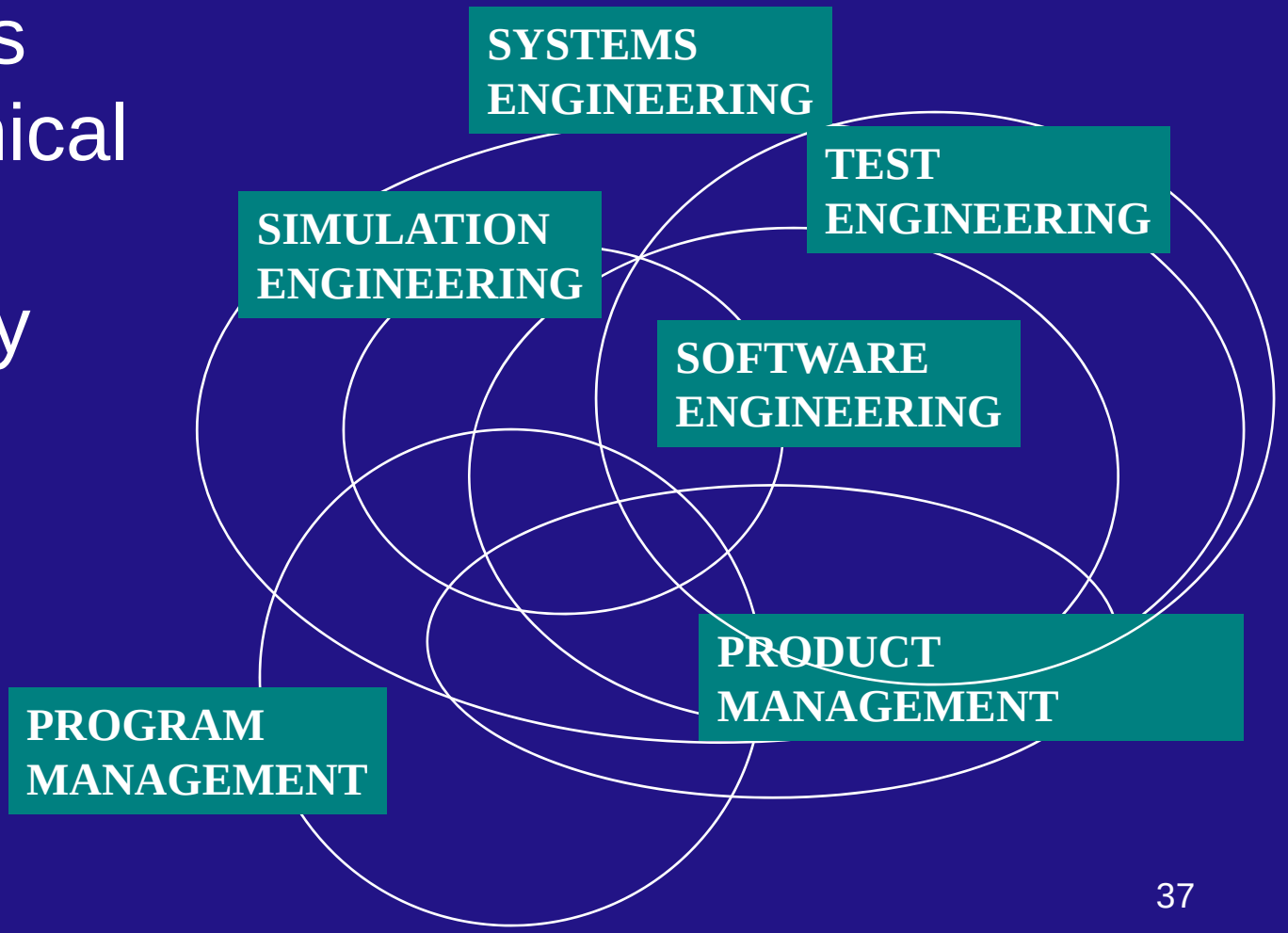
- **Systems Engineering … interdisciplinary approach … to enable the realization of successful systems. … defining customer needs and required functionality …, documenting requirements, then proceeding with design synthesis and system validation while considering the complete problem: (Concept, Design, Development, Operations, Performance, Test, Manufacturing, Cost & Schedule, Training & Support, Disposal)**

- **Systems Engineering integrates … disciplines … into a team effort forming a structured development process …. Systems Engineering considers … business and technical …**

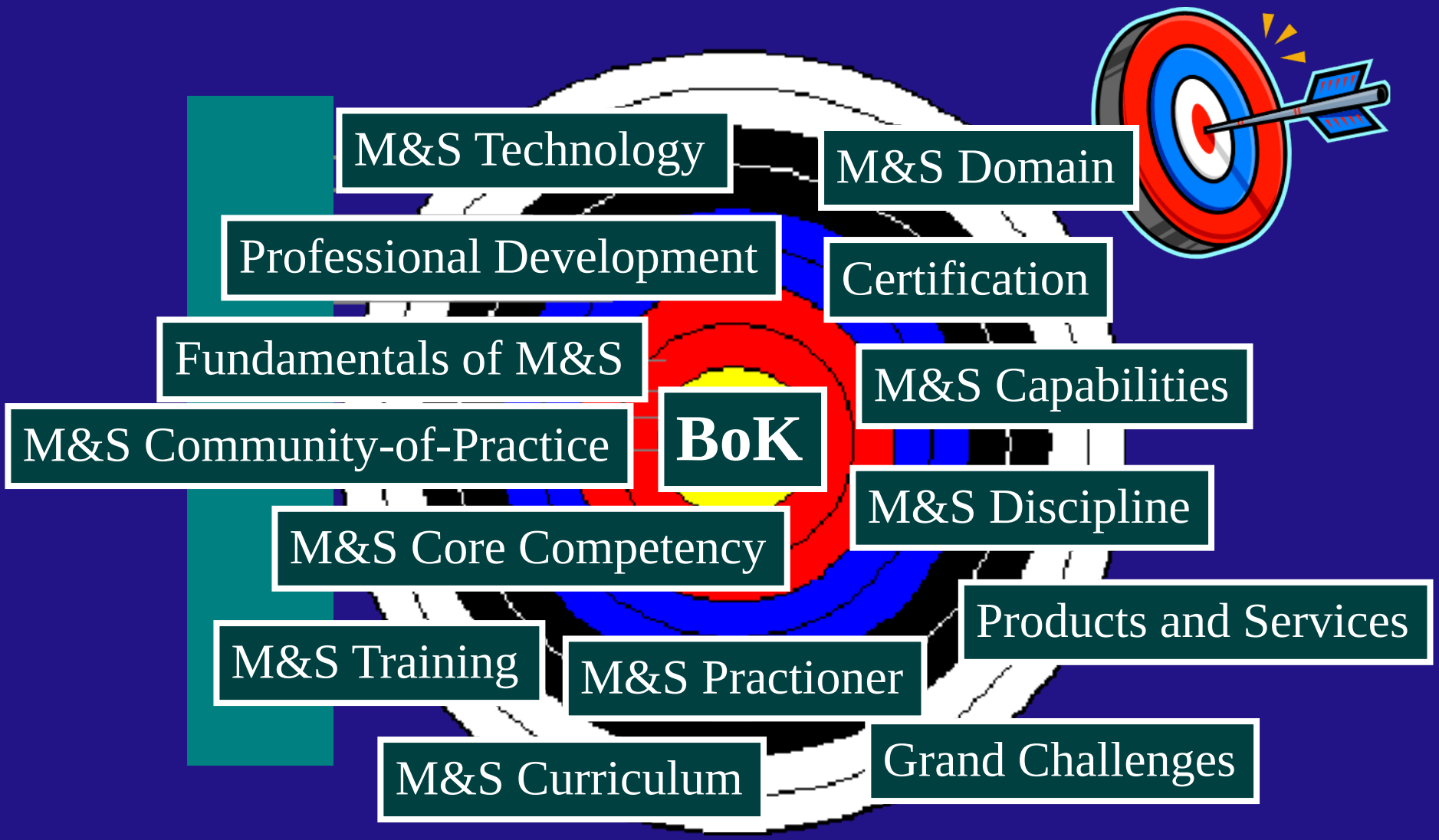
INCOSE
INTERNATIONAL COUNCIL ON SYSTEMS ENGINEERING

Relationships Among Technical Disciplines

Relationships among technical disciplines are inherently complex…



BOK at the core of the issue



Necessity and Sufficiency Criteria for M&S ‘Core’ Concepts

- Completeness
  - Comprehensiveness of scope
  - Detail of basis
- Definitiveness
  - Selective discrimination versus ‘other’ fields
  - Unique in ensemble, not individually
- Unitary Cohesion
- Correctness
  - Consistency
  - Truth

Desiderata for Specification of of M&S 'Core' Concepts

- Independence
- Minimalism
  - (therefore) Orthogonality
- Plausibility
- Richness
- Concreteness
- Provability ?

Existence

- Existence – *a priori* assumption that the referent exists, *de facto* if not *de jure*
- The fundamental significance of existence for M&S is that one way or another, there is something that is being represented.
- Discriminating the referent is a profound challenge to practice
- Precision in referential specification is both necessary and uncommon

Intention

- Intention – purposeful, volitional assumption of specified consequence (versus ‘intentionality’)
- The intentional targets of the M&S asset are, after all, achievement of adequate representation and support of necessary inference
- Intention drives developmental implementation and grounds qualification

Causality and Determinism

- Causality - the guarantee that a given antecedent event or change-of-state in a system is a necessary and sufficient condition for some given subsequent event or change-of-state in the same system.
- Appreciating causality in referents and achieving effective complementary (dual) relations within the representation are key to representation and intention.

Representation

- Representation – where one entity or system (the representation) *stands in lieu of* another entity or system (the referent) for the purpose of being subjected to operations or observation which are not possible or desirable to apply to the original referent entity or system.
- Representation is the single concept that distinguishes modeling from most other disciplines and technical perspectives.

Representation - Relation

- Representation relation - where *a* represents *b* denoted *aRb*, and where what *a* 'says about' *b* may be made (and confirmed) to be (sufficiently) similar to what *b* really 'is'
- Intellectual Basis:
  - Logic of relations
  - Binary relations aRb
  - Similarity relations
  - Mapping relations
  - Symmetry, Conservation, and Invariance
  - Group Theory

Representation - Process

- Observation - (actually, or virtually) of the referent to appreciate its salient qualities
- Abstraction - The *con*ception of the referent based on our *per*ceptual observations… sufficient to support model implementation in its eventual representational milieu
- Quality management – determination and control of the adequacy of representational artifacts

Logical Inference

- Inference - achievement of new knowledge from available information by use of any of a series of eclectic techniques … not unique to modeling
- Three fundamental modes of inference characterize M&S development and use:
  - abstraction via analysis
  - confirmation of representation-implementation
  - asset employment through inferential decision, understanding, or influence
- This specialized use-pattern of inference substantiates the demonstration of M&S as a specifically identifiable discipline

Core M&SBOK

Science & Technology

- Data, variables
- Models (Modeling formalisms, Model processing)
- Experimentation
- Model behavior (Types, Generation, Processing)
- M&S life cycle
- Types of simulation
- Agent-directed simulation

As a testimony of the richness of concepts in M&S:
A list of over 100 Types of Variables
(from the M&S dictionary) (Ören et al, 2006)

Across, Action, Activation, Algebraic, Allocated, **Antithetic**, Arbitrary, Argument, Artificial, Attached, Auxiliary, Behavior, Binary, **Boolean**, Bounded, Class, Constrained, Continuous, **Continuous-change**, Controlled, Coordination, Correlated, Decision, Declared, Declared Random, Dependent, Descriptive, Deterministic, Discrete, **Discrete-change**, Discrete-time, Discriminant, Dual, Dummy, Endogenous, Essential, Exogenous, Experimental, Experimentation, External, **Externally generated**, **Flow**, Formal, Free, **Fuzzy**, Gaussian, Global, Goal, Holistic, Independent, **Initialized**, Input, Instance, Instantiated, **Instrumentable**, Instrumental, Instrumented, Internal, Internally generated, Interpolated, Irrelevant, Key, Lag, **Lagged**, Latent, Lead, Level, **Linguistic**, Local, **Logical**, Monitored, **Nonnumerical**, Nonobservable, Numerical, Observable, **Output**, Qualified, **Qualitative**, Quantified, Quantitative, Random, Rate, Relevant, Run control, Simple, Slack, Stabilized, **State**, Statistical, Stochastic, Subscripted, Temporal, Temporary, **Through**, Time, Transition, Typed, Uncontrollable, Uninitialized, Yoked.

Models

Detailed taxonomies exist (even since 1970s)

Some classifications are based on:

- nature, existence & trajectory of variables
- functional relationships of variables
- formalisms used to describe the models
- intended use
- disposition of submodels
- organization of submodels
- goals to be pursued

Models - Fundamental issues

Complexity, Model taxonomies, ontologies

Systems science, systems approach, systems view

Modeling approaches for decomposition of problems
Conceptual modeling

Experimentation

Simulation run

- Length of the run, Number of runs, Warm-up period
- Steady-state period
- Antithetic run

(Automation of) Statistical design of experiments

Specification of experimental conditions

- Experimental frame
- Applicability of experimental frame to a model
- Scenario specification
- Composable and synthesizable scenarios
- (Composable/ Reconfigurable) Synthetic environments

Analysis of simulation results

- Post simulation analysis and report
- Post live/virtual/constructive simulations reports

Multisimulation
(to experiment with several aspects of reality simultaneously

Core M&SBOK

Technology

- Languages, tools, toolsets
- Comprehensive simulation-based problem solving environments
- Infrastructure
  - Standards, repositories, libraries

Standards

http://www.site.uottawa.ca/~oren/MSBOK/refs-standards.htm

Standardization (Rationale, Mailing List)

ANSI/ANS-3.5-1993;W1998: Nuclear Power Plant Simulators

IEEE Computer Simulation Standards

IEEE Learning Technology Standards Committee

ISO TC 163/WG2 - Simulation Standards

NIST SSC Simulation Standards Consortium

NTSA SSC Standards Standing Committee

SAE - Human Biomechanics and Simulation Standardization Committee

SISO - Simulation Interoperability Standards Organization

System Biology Standards

TARDEC - US Army Tank-Automotive Research Development Center

Techstreet - Available Simulation Standards (search with: simulation standard)

US Army Model and Simulation Standards

US Army: AMSO SNAP (Army Model and Simulation Office Standards Nomination and Approval Process

US Army: ASTARS (Army Standards Repository Systems - Army M&S standards)

US Army's Approach to Modeling and Simulation Standards for C4I Interfaces

US Navy (NMSO) SNEACRS: Standards Nomination, Evaluation, Advocacy and Central Repository System

Repositories

- Data bases for:
  constants, parameters, auxiliary parameters
  data for model identification, model fitting
- **Specifications** of:
  models **Model bases** and **model repositories**,
  physical environments, synthetic environments,
  scenarios, experimental frames, studies
- Simulation components
  (*not just program components*)
  (reusable, extensible, [dynamically] composable)

Core M&SBOK

- Reliability and quality assurance
  - Errors
  - Validation
  - Verification
- Professional Ethics for simulationists

M&S: Ethics

- **http://www.site.uottawa.ca/~oren/SCS_Ethics/ethics.htm**
- **http://www.scs.org/ethics/**

A **Code of Ethics** (**by SCS**) for Professional Simulationists exist . The **Code is adopted by**:

- - Society for Modeling and Simulation International
- - Mcleod Institute of Simulation Sciences
- - McLeod Modeling and Simulation Network
- - Simulation Interoperability Standards Organization
- - Alabama Modeling and Simulation Council

- Ottawa Student Chapter of the SCS.

- NATO Modeling and Simulation Group

- DLM

Core M&SBOK

- History
  - Lessons learned (Best practices)
- Trends, challenges, desirable features

- Maturity of

- Individuals

- Organizations

M&S: History

Hardware:

- Analog simulation: Differential analyzer
- Hybrid simulation
- Digital simulation

Software: languages, tools, techniques, environments

- M&S languages: Early languages and their critique
- M&S environments: Conventional, AI support

Applications

- Canon ball problem
- Simulators: First pilot trainer of Link (1929)
- Early applications: Space flight simulations

Techniques:

Visualization for simulators, synthetic environments

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Intended Uses (cases) and Characteristics

- Academia
  - Curricular Development
  - Disciplinary Identification…
- Industry
  - Personnel Hiring, Training
  - Technical Investment
  - Marketing…
- Government
  - Planning
  - Investment
  - Policy…
- Professional Society
  - Guidance…

Topics of Interest

SimSummit

1

Commercial	Education	Government	Societies

2

TOPICS
TECHNOLOGY
Research Agenda
Conceptual modelling
Composability
Interoperability
Data Management
Architecture Management
Standards
PROFESSIONAL DEVELOPMENT
Stakeholders
Community-of-Practice
WD Needs / Requirements
Body-of-knowledge Specification
Curricular Management
Professional Certification
Institutional Accreditation
Code of Ethics
INDUSTRIAL DEVELOPMENT
Identity, recognition
Scope
Fragmentation Versus Synergy
Labor Classification Codes
Industrial Classification Codes
M&S Asset (life-cycle) Management
Organizational Relations
Event Coordination
BUSINESS PRACTICE
Economics of M&S
M&S Market Description
M&S-based Enterprise
Business Case Specification
Acquisition/Procurement Application
M&S Investment (Techonology/Asset/Application) and ROI
Reuse of M&S assets
Cost of ... M&S asset development, uses, etc.
Value of ...
Economic Impact

PROFESSIONAL DEVELOPMENT

- Stakeholders
- Community-of-Practice
- WD Needs / Requirements 3
- Body-of-knowledge Specification
- Curricular Management
- Professional Certification
- Institutional Accreditation
- Code of Ethics

Enterprise Environment

Root Level

First Tier

Secon

...

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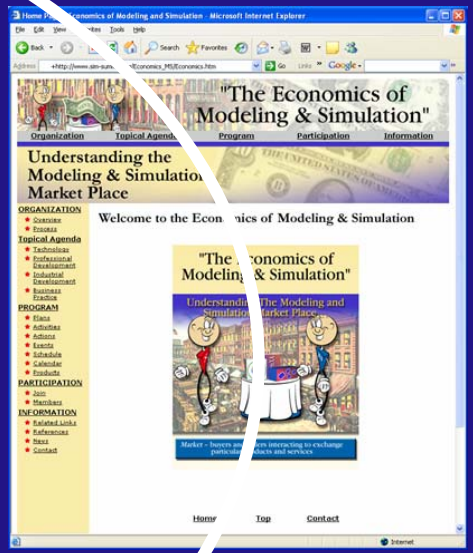
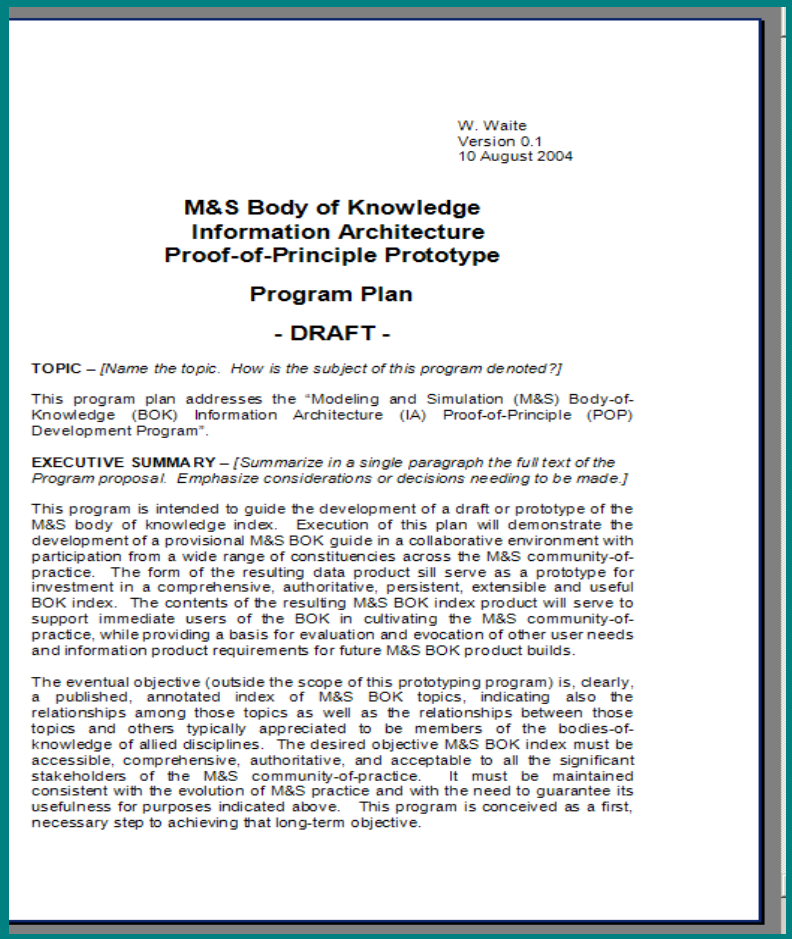


Collaborative Campaign



W. Waite
Version 0.1
10 August 2004

M&S Body of Knowledge
Information Architecture
Proof-of-Principle Prototype

Program Plan

- DRAFT -

TOPIC – *[Name the topic. How is the subject of this program denoted?]*

This program plan addresses the "Modeling and Simulation (M&S) Body-of-Knowledge (BOK) Information Architecture (IA) Proof-of-Principle (POP) Development Program".

EXECUTIVE SUMMARY – *[Summarize in a single paragraph the full text of the Program proposal. Emphasize considerations or decisions needing to be made.]*

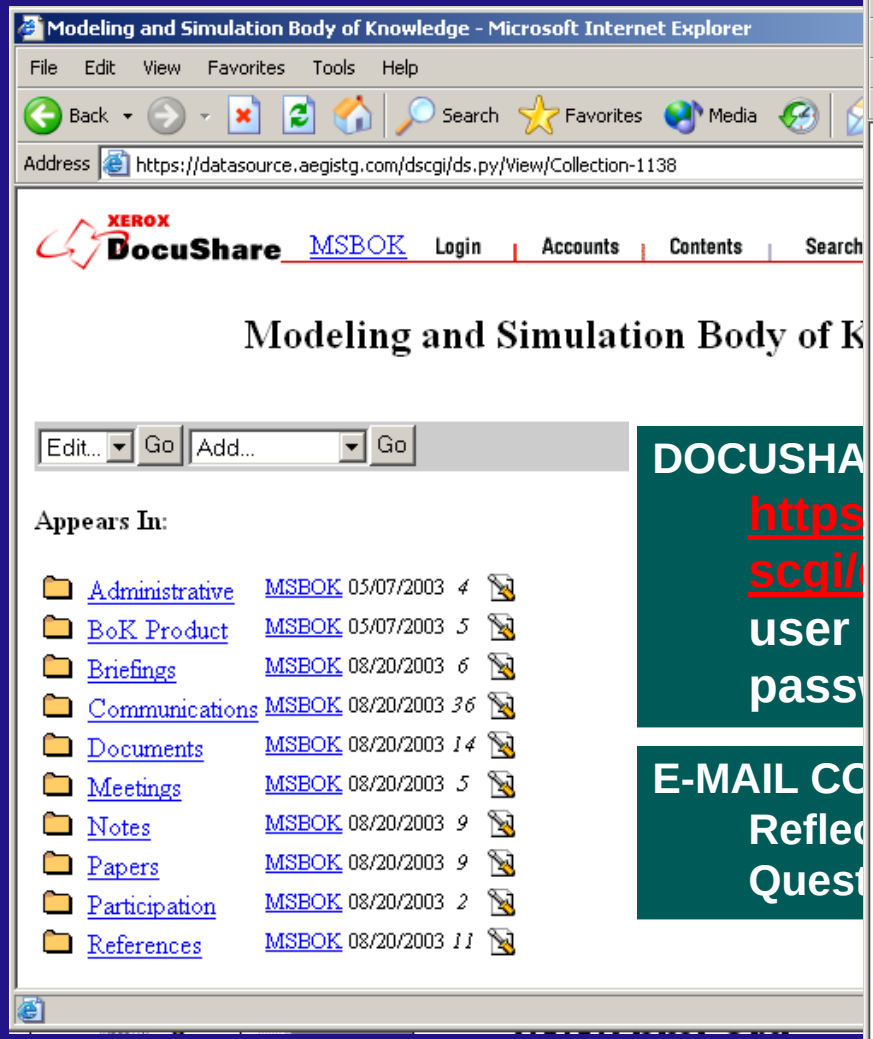
This program is intended to guide the development of a draft or prototype of the M&S body of knowledge index. Execution of this plan will demonstrate the development of a provisional M&S BOK guide in a collaborative environment with participation from a wide range of constituencies across the M&S community-of-practice. The form of the resulting data product sill serve as a prototype for investment in a comprehensive, authoritative, persistent, extensible and useful BOK index. The contents of the resulting M&S BOK index product will serve to support immediate users of the BOK in cultivating the M&S community-of-practice, while providing a basis for evaluation and evocation of other user needs and information product requirements for future M&S BOK product builds.

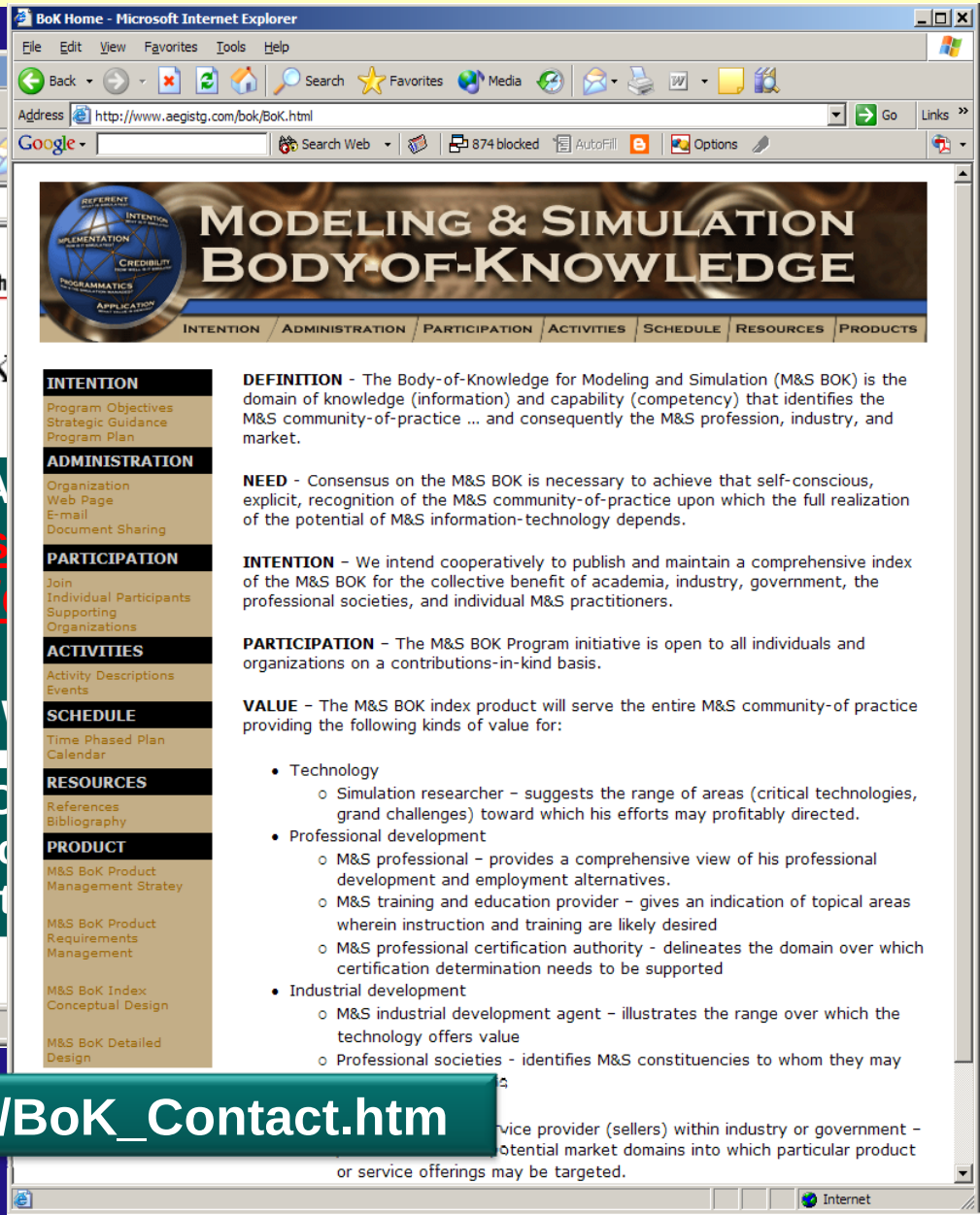
The eventual objective (outside the scope of this prototyping program) is, clearly, a published, annotated index of M&S BOK topics, indicating also the relationships among those topics as well as the relationships between those topics and others typically appreciated to be members of the bodies-of-knowledge of allied disciplines. The desired objective M&S BOK index must be accessible, comprehensive, authoritative, and acceptable to all the significant stakeholders of the M&S community-of-practice. It must be maintained consistent with the evolution of M&S practice and with the need to guarantee its usefulness for purposes indicated above. This program is conceived as a first, necessary step to achieving that long-term objective.

STRATEGIC GUIDANCE:

- Action Orientation
- Product Attributes
- Product Development Risk Sensitivity
- Program Management CONOPS
- Broad Socialization
- M&S Community-of-Practice Context

Collaboration Infrastructure

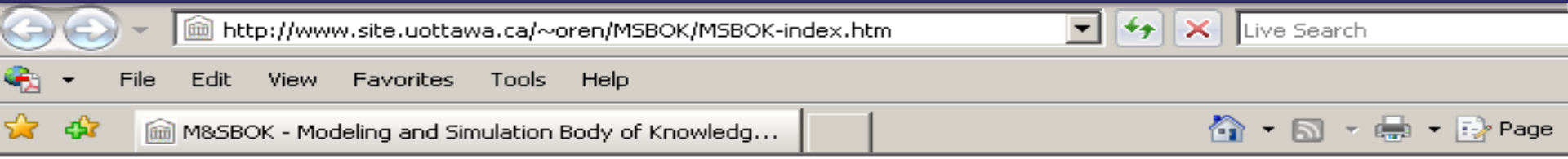




http://www.sim-summit.org/BoK/BoK_Contact.htm

Collaboration Infrastructure

http://www.site.uottawa.ca/~oren/MSBOK/MSBOK-index.htm



Modeling and Simulation Body of Knowledge (M&SBOK)

Being prepared under the auspices of
the National Training Systems Association (NTSA)

After completion, will be merged with SimSummit-BOK

Table of Contents

Preliminary	Introduction	Terminology	Big Picture
Core Areas	Supporting Domains	Mutual Contributions	References

Preliminary

M&SBOK Development Project
Versions and Revisions
- Version History
- Members of the Review Committee

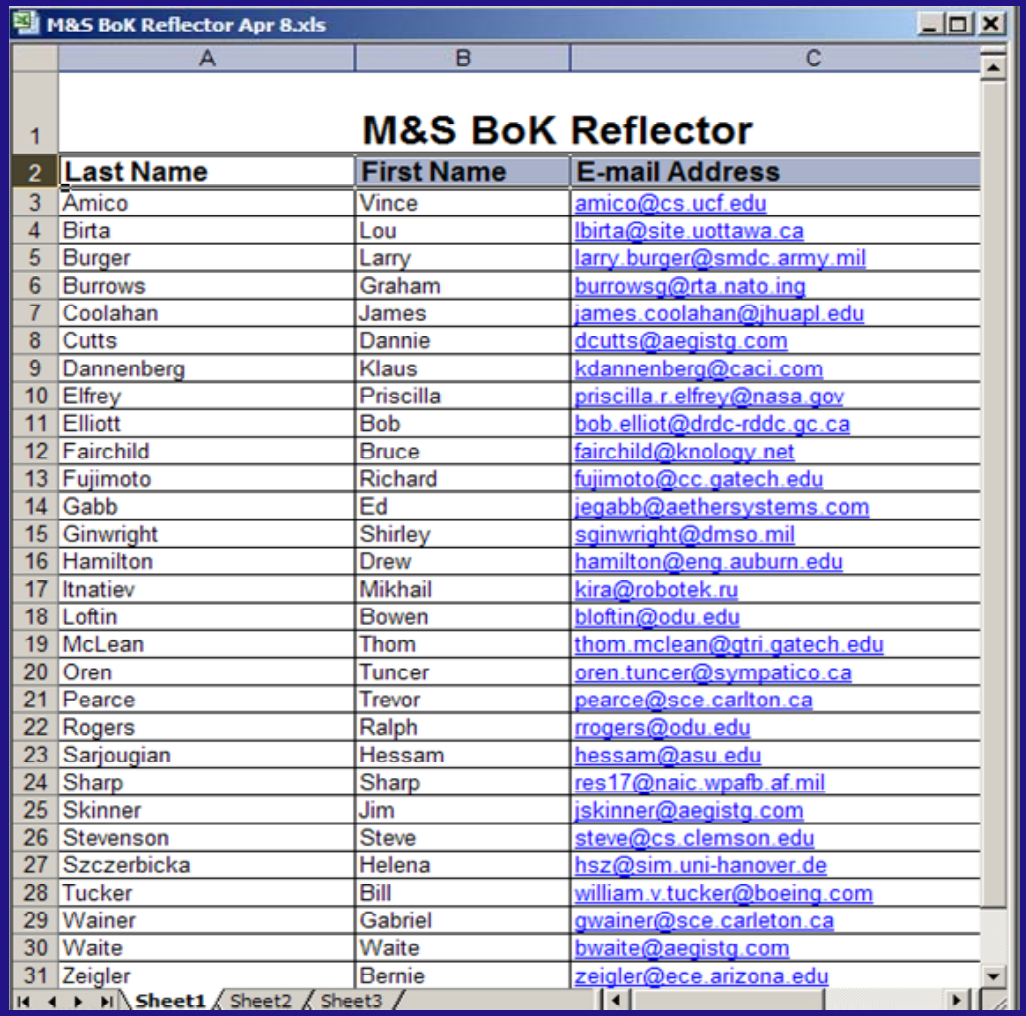
Recommendations by Members of the Review Committee

Please note:
- You are invited to send your recommendations that you feel should be taken into consideration in the preparation of the M&SBOK.
- Members of the Review Committee will be informed when a major draft is finished.

International Participation

- Solicit International participation in M&S BOK specification by name of individual and organization.
- Document world-wide consensus acceptance of final M&S BOK index data products.

Individual Participation



M&S BoK Reflector Apr 8.xls

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Sheet1 Sheet2 Sheet3

And the M&SBOK Review Committee at:

http://www.site.uottawa.ca/~oren/MSBOK/revCom.htm

Body-of-Knowledge Publication

- Treat the identification, development, and maintenance of the BOK as we would any other product development effort:
  - Identify users and uses
  - Elicit requirements
  - Create a conceptual model
  - Determine resources required/available
  - Identify objectives, goals, and metrics
  - Identify the Products to be developed
  - Identify Risks
  - Develop design and consider design constraints
  - Implement according to a schedule
  - Verify, Validate, and Accredit the results

Work Products

- Technical bibliography
- User needs database
- Product Conceptual design specification
- Product Detailed design
  - Information architecture
  - Topical data elements
  - BOK 'Document' Implementation Specification
- Proto Version 1
- Proto Version 2

WE HAVE SEEN HIGHLIGHTS OF

I. INTRODUCTION
II. BOK *TECHNICAL CONCEPTS*
III. M&S BOK *CONTENT*
IV. M&S BOK *EVOLUTION*
V. CONCLUSION

CONCLUSION / MESSAGE (1/2)

Simulation offers a very rich paradigm

1. to **perform experiments** with dynamic models &
2. to **provide experience** either
   - 2.1 for **entertainment** or
   - 2.2 to **develop/enhance** three types of **skill**, i.e., motor skills, decision making skills, & operational skills.

- Lack of an explicit consensus of an M&S Body-of-Knowledge inhibits its evolution.

CONCLUSION / MESSAGE (2/2)

- Having M&S acknowledged as a distinct branch of knowledge is important in **advancing the profession, industry and marketplace**.
- A **concerted effort** will ensure that M&S as a profession evolves in a timely manner.
- This will **enhance its usefulness** in many complex problems.

You are welcome to contribute to this "Open Source" Activity.

Many Thanks!