China - September 2011

Beijing: Beihang University, School of Automation and Electrical Eng.
Changsha: National Univ. of Defense Technology, System Simulation Lab.

Future of Modeling and Simulation:
Normative Views, Desirable Growth Areas & Challenges

Tuncer Ören, Ph.D.
Professor Emeritus
School of Electrical Engineering and Computer Science
University of Ottawa
Ottawa, Ontario, Canada
http://www.site.uottawa.ca/~oren/
The Aims:

• To develop a framework to elaborate on –in a *systematic* manner– the desirable growth areas and challenges for the future of modeling and simulation; &

• to start populating this framework
Grand Challenges for Modelling and Simulation
Organizers:
August 25-30, 2002, Seminar 02351
Dagstuhl-Seminar-Report 350
Some references (3/3)

• The 5th International Conference on Grand Challenges in Modeling and Simulation (GCMS2012), Part of SummerSim2012, Genoa, Italy, July 8-11, 2012,


• Grand Challenges in Modeling & Simulation, Part of the 2010 Summer Simulation Multiconference (SummerSim 2010), Program

• 2009 Conference on Grand Challenges in Modeling and Simulation (GCMS'09), Part of the 2009 Summer Simulation Multiconference (SummerSim'09)

• Grand Challenges in Modeling & Simulation 2008 (GCMS'08) Part of the 2008 Summer Simulation Multiconference (SummerSim'08), Edinburgh, Scotland.
Publications, Presentations and Other Activities of Dr. Tuncer Ören on Modeling and Simulation: Normative Views for Advancement and Advanced Methodologies
updated: 2011-08-25

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An article based on this presentation will be submitted to the:

“Until we attempt to simulate a system, we don’t realize how little we know about it.”

Donald Knuth

Anytime a phenomenon is explained, I remember this quote, to realize how deep and detailed the information is; or is not.

Simulation requires detailed knowledge; much more than knowledge sufficient to talk about a topic, or an issue.
It is imperative that
(1) we have a comprehensive view of M&S &
(2) to develop an appropriate framework for
elaboration
For comprehensive view & several aspects of M&S, see:


Our arguments can *start with*: **Experiments** and **experience** are the essence of modeling & simulation (M&S)

- Simulation is performing goal-directed **experiments** using a model of a dynamic system.

- Simulation is gaining **experience**, by use of a representation of a system,
  - *to enhance* any one of three types of **skills**:
    -- *motor skills* (by virtual simulation, or simulators),
    -- *decision making and communication skills* (by constructive simulation, gaming simulation),
    -- *operational skills* (by live simulation)
  - *for entertainment* purposes (simulation games)

for six aspects of M&S

1. Tools
2. Profession
3. Synergies
4. Science & Methodology
5. Applications
6. Reliability

Advantages of this systematic approach:
1. Elaboration on the aspects (change, add) &
2. For each aspect, modify, add other challenges

1. Tools
2. Profession
3. Synergies
4. Science & Methodology
5. Applications
6. Reliability
Six aspects of M&S

1. M&S within the spectrum of tools
2. M&S profession
3. Synergies of simulation with some disciplines
4. Science & Methodology
5. Applications
6. Reliability
He that would perfect his work must first sharpen his tools.

Confucius, 551-479 BC
### M&S from the Tool Hierarchy:

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<tr>
<th>Levels</th>
<th>Types of tools</th>
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<td>Cybernetic tools</td>
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<td>Level</td>
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<td>• metallic tools</td>
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<td>Additional features</td>
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<td>Ability to perform work</td>
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<td>Power tools</td>
<td>• simple power tools</td>
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<td>• machine tools</td>
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<td>• integrated machines (transfer machines)</td>
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<td>Additional features</td>
<td>• (Energy) Ability to perform work</td>
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<td>Cybernetic tools</td>
<td><strong>Knowledge processing (kp) machines</strong></td>
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<td>• Machines for kp: Computers</td>
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<td>• Machines with kp abilities (smart machines)</td>
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AI-directed simulation
• Simulation of intelligent entities
• AI for simulation
  - AI- supported simulation
  - AI-based simulation
Soft computing-directed simulation

Publications, Presentations and Other Activities of Dr. Tuncer Ören on:
*Simulation, Artificial Intelligence and Cybernetics*
Agent-directed simulation

- Simulation for agents:
  - agent simulation

- Agents for simulation:
  - agent-supported simulation
  - agent-based simulation

Also in synergies of M&S with software agents
Challenge:

- Simulation-based problem solving environments
- Simulation-based Computer-aided design (CAD)
- Simulation-based (several types of) engineering
- Simulation-based science
- Simulation-based education
- Simulation-based social science
- Simulation-based training: for conflict management
Six aspects of M&S

- M&S within the spectrum of tools
- M&S profession
- Synergies of simulation with some disciplines
- Science & Methodology
- Applications
- Reliability
List of Modeling and Simulation (M&S) Associations/Organizations/Committees (105) Centers/Groups (34) Military Organizations (27)

http://www.site.uottawa.ca/~oren/links-MS-AG.htm
List of Modeling and Simulation (M&S) Associations/Organizations/Committees

INDEX
Associations/Organizations?Committees
  High Level Recognition of M&S
  Networking of Professional Organizations
  Associations - International
  Associations/Groups - by Country
  Associations - by Region/Language
Research Centers/Groups
Military Organizations
  NATO
    By Country (Canada, Korea, Sweden, Turkey, UK, USA)

As a testimony of high level recognition of M&S see (in chronological order):
  - USA – House Resolution 487 (2007 July 16)
  - USA – A companion bill – S. 616 (2009 March 17)

Associations/Organizations/Committees

High Level Recognition of M&S (1)
  - US Congressional Modeling and Simulation Caucus (News) (Congressman J. Randy Forbes)

Networking of Professional Organizations (20)
  - MSLS - M&S leadership Summit
  - SimSummit
  - G.A.M.E.S, Synergy Summit (Government, Academic, Military, Entertainment and Simulation)
List of Modeling and Simulation (M&S) Associations/Organizations/Committees

Associations - International (26)

- **ABSEL** - Association for Business Simulation and Experiential Learning
- **ACM SIGSIM** - ACM Special Interest Group on Simulation
- **AIS SIGMAS** - Association for Information Systems Special Interest Group on Modeling and Simulation
- **AMSE** - Association for the Advancement of Modelling and Simulation Techniques in Enterprises
- **ANGILS** - Alliance for New Generation Interactive Leisure and Simulation
- **DIGRA** - Digital Games Research Association
- **EBEA** - The Economics and Business Education Association
- **ESRC SAGE** - Simulating Social Policy for an Ageing Society
- **IASTED** - International Association of Science and Technology for Development
- **IBPSA** - International Building Performance Simulation Association
- **IFIP TC7 WG7.1** - Modelling and Simulation Working Group of the Technical Committee TC 7 (System Modelling and Optimization) of IFIP (International Federation for Information Processing)
- **IGDA** - International Game Developers Association
- **IMA** - International Microsimulation Association (a.k.a. microanalytic simulation)
- **IMACS** - International Association for Mathematics and Computers in Simulation
- **INACSL** - International Nursing Association for Clinical Simulation and Learning
- **INFORMS** - Simulation Society
- **ISAGA** - International Simulation and Gaming Association (affiliated regional gaming & simulation associations can be seen at [ISAGA](#))
- **M&SPCC** - Modeling and Simulation Professional Certification Commission
- **Modelica** - Modelica Association
- **SAE** - Human Biomechanics and Simulation Standardization Committee
- **SAGSET** - The Society for the Advancement of Games and Simulations in Education and Training
- **SCS** - Society for Modeling & Simulation International (Formerly Society for Computer Simulation) ([Ethics](#), **M&SNet, MISS)**
- **SGI** - Serious Games Initiative
- **SSAISB** - Society for the Study of Artificial Intelligence and the Simulation of Behaviour
- **SSH** - Society in for Simulation in Healthcare
# List of Modeling and Simulation (M&S) Associations/Organizations/Committees

<table>
<thead>
<tr>
<th>Associations/Groups/Committees - by Country (38)</th>
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</thead>
<tbody>
<tr>
<td>Australia: OzSAGA - Australian Simulation and Games Association</td>
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<td>Australia: SIAA - Simulation Industry Association of Australia</td>
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<tr>
<td>Bulgaria: Bulsim - Bulgarian Modeling and Simulation Association</td>
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<tr>
<td>China: CASS - Chinese Association of System Simulation</td>
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<td>China: SASS - Shanghai Association for System Simulation (In Chinese)</td>
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<td>Croatia: CROSSIM - Croatian Society for Simulation Modelling</td>
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<tr>
<td>Denmark: DKSIM - Dansk Simuleringsforening (Danish Simulation Society)</td>
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<tr>
<td>Finland: FinSim - Finnish Simulation Forum</td>
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<tr>
<td>France: CNRS-GdR MACS - Groupe de Recherche &quot;Modelisation, Analyse et Conduite des Systemes dynamiques&quot; de CNRS</td>
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<tr>
<td>France: VerSim - Vers une théorie de la Simulation</td>
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<td>Hungary: HSS - Hungarian Simulation Society</td>
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<td>India: C-MMACS - Indian Society for Mathematical Modeling and Computer Simulation</td>
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<td>Italy: ISCS - Italian Society for Computer Simulation</td>
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<td>Italy: Liophant Simulation</td>
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<td>Italy: MIMOS (Italian Movement for Modeling and Simulation)</td>
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<td>Italy: Simulation Team</td>
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<td>Japan: JASAG - Japan Association of Simulation and Gaming</td>
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<td>Japan: JSST - Japan Society for Simulation Technology</td>
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<td>Korea: KSS - The Korea Society for Simulation (in Korean)</td>
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<td>Latvia: LSS - Latvian Simulation Society</td>
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<td>Norway: NFA - Norsk Forening for Automatisering</td>
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<td>Poland: PSCS - Polish Society for Computer Simulation (in Polish)</td>
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<td>Romania: ROMSIM - Romanian Society for Modelling and Simulation</td>
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<tr>
<td>Singapore: SSAGS - Society of Simulation and Gaming of Singapore</td>
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<td>Slovenia: SLOSIM - Slovenian Society for Modelling and Simulation</td>
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<tr>
<td>Spain: AES - Spanish Simulation Society (Asociación Española de Simulación)</td>
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<tr>
<td>Spain: CEA SMSG Spanish Modelling and Simulation Group</td>
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<tr>
<td>Sweden: MoSis - The Society for Modelling and Simulation in Sweden</td>
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<tr>
<td>UK: NAMS - National Association of Medical Simulators</td>
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<td>UK: UKSIM - United Kingdom Simulation Society</td>
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<tr>
<td>USA: AIAA (American Institute of Aeronautics and Astronautics) M&amp;S Technical Committee</td>
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</table>
Aspects of Professionalism in M&S:

1. Knowledge:
   *To solve problems:*
   - M&S BoK
   - Science
   - Technology
   - Application Area(s)
   *How to behave as a simulationist*
   - Code of Professional Ethics

2. Activities:
   - Knowledge Generation and Dissemination:
     (Academia, R&D)
   - Generation of products/services & solving problems
     (Industry)

3. Monitoring:
   - Professional and Ethical Conduct
   - Certification of Professionalism
Knowledge - **Challenges**

- Finalize a universally accepted M&S BoK Index
- Develop practice of maturity levels of individuals and companies similar to the one in [software engineering](https://www.softwareengineering.stackexchange.com)
- Develop universal M&S curricula
- Continue establishment of graduate degrees in M&S with specializations in different application areas
- Job Categorization
Knowledge - Challenges

• Develop simulation systems engineering (also for social systems)

• Consider use of simulation (simulators) for pilot training;
  & remember that most social systems – even though somehow more resilient – are much more complex.

• Decision skills can be enhanced by simulation-based experiences.
  Hence, simulation-based decision in complex social systems can be beneficial in the education.
Six aspects of M&S

- M&S within the spectrum of tools
- M&S profession
- Synergies of simulation with some disciplines
- Science & Methodology
- Applications
- Reliability
Synergies of simulation with some disciplines

Synergies between 2 entities A & B can be:

- **First order synergy:**
  Direct contributions between them

- **Higher order synergy:**
  Indirect contributions between them
Synergies of simulation with some disciplines

- Modeling, model processing; problem solving
- System theories
- Software agents
- Artificial Intelligence
- Software engineering
- Systems engineering
- Computation
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<th>of</th>
<th>M&amp;S</th>
<th>System theories</th>
<th>Systems eng.</th>
<th>Software eng.</th>
<th>Artificial intelligence</th>
<th>Software agents</th>
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<td>Modeling &amp; Simulation</td>
<td>System Theories</td>
<td>- Basic tool of inquiry for complex problems</td>
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<td>Software Engineering</td>
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<td>- Paradigm for module interfacing</td>
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<td>- Cognitive simulation (i.e., simulation of intelligent entities)</td>
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<td>- Simulation for agents</td>
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<td>- Agent simulation (i.e., simulation of entities modeled as agents)</td>
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<td>System Theories</td>
<td>Modeling &amp; Simulation</td>
<td>- Bases for system design, analysis</td>
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<td>- Advanced modeling formalisms</td>
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<td>- Bases for symbolic model processing</td>
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<td>- Formalisms to design complex software systems as special cases of</td>
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<td>Artificial Intelligence</td>
<td>- Bases for modeling cognitive systems such as, learning systems,</td>
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<td>understanding systems, and goal-directed systems.</td>
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<td>- Software architectures for modeling and simulation</td>
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<td>- Modeling smart systems/systems/machines/mechanisms which can</td>
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<td>Artificial Intelligence</td>
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<td>• AI for simulation:</td>
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<td></td>
<td>- AI-supported simulation (for user/system interfaces)</td>
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<td></td>
<td>- AI-based simulation (for the generation of model behavior, e.g., rule-based simulation, qualitative simulation)</td>
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<td>• Agents for simulation:</td>
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<td>- Agent-supported simulation (for user/system interfaces)</td>
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<td>- Agent-based simulation (for the generation of model behavior)</td>
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<td>• Modeling intelligent systems (systems/machines/mechanisms which can perform their functions better with the advanced knowledge processing abilities, even though their main functionalities are not knowledge processing)</td>
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<tr>
<th>System Theories</th>
<th>• Intelligent models (Several types of intelligence)</th>
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<tr>
<td>Software Engineering</td>
<td>• Intelligent software; • AI in software life cycle</td>
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“The only book to present the synergy between modeling and simulation, systems engineering, and agent technologies expands the notion of agent-based simulation . . .”

550 pages
September 2009
2010 June 3-5, Kusadasi, Turkey
Faculty of Engineering, Gediz University, Turkey
- Invited speaker at the opening plenary session:
Synergies of Simulation, Agents, and Systems Engineering

Agent-directed simulation
• Simulation for agents:
  - agent simulation
• Agents for simulation:
  - agent-supported simulation
  - agent-based simulation
Synergies of simulation, agents, and systems engineering

(abbreviations: ADS: Agent-directed simulation ADSS: ADS systems SE: Systems engineering)

First order synergy

Second order synergy
Synergies of M&S with software agents

Some annual events:
- ADS Symposium at the SpringSim (ADSS)
- ADS track of sessions at the SummerSim
- ADS track of sessions at the EMSS - European Modeling and Simulation Symposium (co-located with the I3M MultiConference)
- ADS track of sessions at MOSIM
- A special issue of an international journal based on selected papers of the ADSS.

Challenge: At Asia Simulation Conferences: ADS track of sessions, instead of merely Agent-based Simulation sessions.
Challenges:
• Cognitive simulation
• Emotive simulation
## Possibilities for Enriched (Augmented) Reality:

<table>
<thead>
<tr>
<th>Operator</th>
<th>Equipment</th>
<th>Real</th>
<th>Virtual</th>
</tr>
</thead>
<tbody>
<tr>
<td>- <strong>Real</strong></td>
<td>- Live simulation (a human operator uses <em>virtual equipment</em> (guns))</td>
<td>Virtual simulation</td>
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<tr>
<td>- Virtual</td>
<td>- Automated vehicles (auto pilot, aircraft without pilot; vehicle without driver)</td>
<td>- Simulator</td>
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<td>- Virtual simulator</td>
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<td>e.g., <em>an AI aircraft</em> (in dogfight)</td>
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</table>
Six aspects of M&S

- M&S within the spectrum of tools
- M&S profession
- Synergies of simulation with some disciplines
- Science & Methodology
- Applications
- Reliability
Perceptions of M&S from different perspectives*

* To be able to explore M&S from a wider paradigm

- Purpose of use
- Problem to be solved
- Connectivity of operations
- Types of knowledge processing
- Philosophy of science
Simulation and Real System:

2 categories of simulation:
(with respect to connectivity of operations)

- **Stand-alone simulation**
  (operations of the simulation and the system of interest are independent)

- **Integrated simulation** (symbiotic simulation)
  (operations of the simulation and the system of interest are interwoven)
(Operations of simulation and the system of interest are interwoven.) **Integrated simulation**

Simulation **enriches** real-system operation.

Real-System Enriching Simulation

Simulation **supports** real-system operation.

Real-System Support Simulation
Simulation and Real System:

Integrative simulation *(symbiotic simulation)*

To (enrich) augment reality

In enriched *(augmented or mixed)* reality simulation, real and virtual entities (that can be people or equipment) and the environment can exist at the same time.

Hence, operations can take place in a richer *augmented reality environment*.

*Reality is a special case of simulation!*
Simulation **enriches** real-system operation.  
**Real-System Enriching Simulation (RSES)**  
The SOI and the simulation program **operate simultaneously** and provide augmented- (enhanced- or mixed-) reality for:  
• Decision support (on-line diagnosis)  
• Training  
• Realistic virtual reality (VR) environments

Simulation **supports** real-system operation.  
**Real-System Support Simulation (RS3)**  
The SOI and the simulation program **operate alternately** and provide predictive displays for:  
• Decision support  
• On-the-job training
Perceptions of M&S from different perspectives*

* To be able to explore M&S from a wider paradigm

- Purpose of use
- Problem to be solved
- Connectivity of operations
- Types of knowledge processing
- Philosophy of science
Types of knowledge processing:

M&S is:

- a computational activity
- a systemic activity & system theory-based activity
- a model-based activity
- a knowledge-generation activity
- a knowledge-processing activity
Considering M&S as a computational activity two categories of advances (challenges) are possible:

- Computers
- Type of computation
Considering M&S as a computational activity two categories of advances (challenges) are possible:

• **Computers** (some examples)
  - Cloud simulation
  - Massively parallel simulation
  - Simulation on portable devices
  - Wearable computer simulation

• **Type of computation**
Considering M&S as a computational activity two categories of advances (challenges) are possible:

• Computers

• Type of computation (some examples)
  - Fuzzy simulation
  - Mixed fuzzy & numerical simulation
Types of **knowledge processing**:

**M&S is:**

- a computational activity
- a systemic activity & system theory-based activity
- a model-based activity
- a knowledge-generation activity
- a knowledge-processing activity
From a systemic point of view, simulation can be used to find the values of output, input, or state variables of a system; provided that the values of the two other types of variables are known.

(W. Karplus, 1976)
<table>
<thead>
<tr>
<th>Type of problem:</th>
<th>Given</th>
<th>Find</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analysis</td>
<td>input</td>
<td>state</td>
</tr>
<tr>
<td>Design</td>
<td>input</td>
<td>output</td>
</tr>
<tr>
<td>Control</td>
<td>state</td>
<td>output</td>
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</tbody>
</table>
Types of Simulation Input Data

Digital sensory input data

Analog sensory input data

Sensor → Simulation

Learned data

Sensory data

Neural net → Simulation

Inter-simulation data

Input data

Another simulation → Simulation

(Online) Input data

Simulation → challenges

challenges
<table>
<thead>
<tr>
<th>Source of input</th>
<th>Mode of input</th>
<th>Type of input</th>
</tr>
</thead>
</table>
| Exogenous input         | Passive acceptance of exogenous input (imposed or forced input) | **Type of access to input:** coupling, argument passing, knowledge in a common area, message passing.  
**Nature of input:**  
- *Data* *(facts)*  
- *Forced Events*  
- *Sensation* (converted sensory data: from analog to digital; single or multi sensor: sensor fusion)  
- *External goals* *(imposed goals)*  
- *Online knowledge* |
|                         | Active perception of exogenous input (perceived input) | - *Perception* (interpreted, sensory data and detected events)  
-- includes: decoding, selection (filtering), recognition, regulation  
- *Perceived goals*  
- *Evaluated inputs*  
-- evaluation of inputs (acceptability)  
-- evaluation of source of inputs (reliability, credibility) |
<table>
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<tr>
<th>Source of input</th>
<th>Mode of input</th>
<th>Type of input</th>
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<tbody>
<tr>
<td><strong>Endogenous input</strong> (internally generated input)</td>
<td><strong>Active perception of endogenous input</strong></td>
<td><strong>- Introspection</strong> (perceived internal facts, events; or realization of lack of them)</td>
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<td><strong>Generation of endogenous input</strong></td>
<td><strong>- Anticipated facts and/or events</strong> (anticipatory systems)</td>
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<td></td>
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<td><strong>- Internally generated questions</strong></td>
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<td><strong>- Internally generated hypotheses</strong> by:</td>
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<td></td>
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<td>-- Expectation-driven reasoning</td>
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<td>(Forward reasoning)</td>
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<td>(Bottom-up reasoning)</td>
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<td>(Data-driven reasoning)</td>
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<td></td>
<td>-- Model-driven reasoning</td>
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<td><strong>- Internal goals</strong></td>
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<td></td>
<td>(internally generated goals)</td>
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**Challenge:** Use endogenous inputs in simulation
Challenges:

• Use of several system theories (evolutionary systems, goal-directed systems, . . .) as a bases for *modeling* and *symbolic model processing* for advanced simulation.

• Use of simulation to study effects of complexity & emergence in non-linear systems.
Types of **knowledge processing**: 

**M&S is:**

<table>
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<tr>
<th>Types of Activity</th>
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<tbody>
<tr>
<td>a computational activity</td>
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<tr>
<td>a knowledge-generation activity</td>
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<tr>
<td>a knowledge-processing activity</td>
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</table>
Challenges:
• Use **conceptual models** to be transformed to computational (programmed) models.
• Model bases to store conceptual models.
• Maintenance of conceptual models instead of computational (programmed) models.
• Develop concepts and tools for interoperability of conceptual models

"conceptual modeling“ [search on Google](https://google.com) (480 000+ hits)
Simulation as a model-based activity

Challenges:

• Symbolic processing of models (this is a very rich paradigm)

• Multi-paradigm modeling for simulation (several categories of possibilities exist)

• DNA-based modeling for dynamic model updates

• ...
Types of knowledge processing:

M&S is:

- a computational activity
- a systemic activity & system theory-based activity
- a model-based activity
- a knowledge-generation activity
- a knowledge-processing activity
Simulation as a knowledge generation activity:

The definition of simulation can be interpreted as follows: “Simulation is model-based experiential knowledge generation.”

This abstraction facilitates the synergy of simulation with other knowledge generation (and processing) techniques:

- optimization
- statistical inferencing
- reasoning (Artificial intelligence)
- hypothesis processing (to be combined with advanced agent-support to generate hypotheses to be tested)
Types of knowledge processing:

M&S is:

- a computational activity
- a systemic activity & system theory-based activity
- a model-based activity
- a knowledge-generation activity
- a knowledge-processing activity
Simulation as a knowledge processing activity

Challenge:

• Advanced visualization techniques, e.g., holographic visualizations.

Six aspects of M&S

- M&S within the spectrum of tools
- M&S profession
- Synergies of simulation with some disciplines
- Science & Methodology
- Applications
- Reliability
Challenge: Simulation-based solutions to World’s important / vital problems

What would be the areas that you would like to suggest?

Or, cite some important problems that you think simulation cannot be used to find a good solution.
Challenge:
Simulation-based enhancement of creativity & innovation?
Challenge:
Simulation-based software development
- for control systems, for example
Challenge:
Add virtual gauges (measurement devices) (with or without threshold controls) to simulation systems

**Challenge:**
Use simulated experiments of material genome knowledge to create new materials.

http://www.materialsgenome.org/

This would be similar to SPICE / PSPICE system used for electronic circuit design.
Six aspects of M&S

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- Reliability
Reliability - Challenges:
Contributions of:

• **simulation to reliability**
  (e.g., reliability of systems, buildings, decisions, . . .)

• **reliability to simulation**
  (validation, verification, QA (Quality Assurance), FA (Failure Avoidance)
  (Ethics in simulation)
Reliability - **Challenges:**

- **Built-in** Quality Assurance
- Failure Avoidance
- Reliability of AI in simulation
  - Reliability of rule-based systems in simulation
- Reliability of agents in simulation

...
Challenge:
Have understanding ability and avoid inabilities and filters that can induce misunderstanding in cognitive simulation in agent-directed simulation.

Ref: Agents with understanding abilities and ways to avoid misunderstanding
Invited seminar, Changsha, China, September 2011
Inabilities and filters that can induce misunderstanding

Ability (inability) to understand:
- meta-model
- perception
- interpretation

Filters for misunderstanding:
- context
- biases
- fallacies
Publications and Presentations of Dr. Tuncer Ören on Modeling and Simulation: Reliability, Quality Assurance (QA), and Failure Avoidance (FA)

(Some statistics)
(Meetings include conferences/symposia/tracks of sessions organized/invited/participated)

<table>
<thead>
<tr>
<th>Periods</th>
<th>Publications</th>
<th>Meetings</th>
<th>Meetings &amp; Others</th>
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<td>2010s</td>
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<table>
<thead>
<tr>
<th>Total publications</th>
<th>63</th>
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</thead>
<tbody>
<tr>
<td>Total meetings</td>
<td>23</td>
</tr>
<tr>
<td>Total</td>
<td>86</td>
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</tbody>
</table>
Some personal views on advancement
“No progress is ever possible by keeping the state-of-the-art, no matter how advanced it is.”

Tuncer Ören
Emulate nature; keep blooming!

Tuncer Ören
• Competition is the essence of progress and necessitates the ability, willingness and drive to **surpass oneself**.

• Those –be it an individual, an institution, or a country– unable to surpass themselves cannot exceed others.

• Therefore, in achieving progress, what is difficult is to **supersede oneself**; then outdoing and even eclipsing others may become possible.

To my current & future colleagues:

Good luck*

in your careers!

*“Luck is what happens when preparation meets opportunity.”

Seneca – Roman philosopher, mid-1st century AD
Thank you for your attention!