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Growing Importance of Modelling and Simulation: Professional and Ethical Implications

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Plan: Modeling & Simulation

1. Terminology
2. Types of usages
3. Some advancement areas
4. Professionalism
5. Importance and responsibilities
6. Ethical implications

Simulation

is goal-directed experimentation with dynamic models, i.e., models with time-dependent behavior.

Experimentation

is one of the key concepts in scientific thinking since Francis Bacon (1561-1626) who advocated it in 1620 in his Novum Organum. (New Instrument)

Bacon's work was a categorical departure from and reaction to "Organon" (the Instrument) which was the title of logical works of Aristotle (384-322 B.C.) which itself had an "unparalleled influence on the history of Western thought."

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Usages of Simulation:

Stand-alone simulation activity: ***the simulation program runs independently from the system of interest.***

Four categories of purpose:

1. Decision making
2. Training to enhance decision skills (gaming simulation)
3. Training to enhance motor skills (simulators)
4. Understanding and education

5 Entertainment (simulation games, animation of dynamic systems)

Decision making

Prediction of behavior or performance of the system of interest within the constraints inherent in the simulation model (e.g., granularity)
Evaluation of alternative models, parameters, experimental and/or operating conditions on model behavior or performance
Sensitivity analysis
Engineering design
Prototyping
Planning
Acquisition
Proof of concept

Usages of Simulation:

Integrated simulation activity: (An emerging area) ***simulation program operates together with the system of interest.***

Two main purposes: to *support* or to *enrich* real system operation

Support of real system operation: the system of interest and the simulation program operate *alternately* to provide *predictive displays*.

Enrichment of real system operation, the system of interest and the simulation program operate *simultaneously*.

Goals: - *on-line diagnosis*

- *augmented reality* (enhanced reality) operation.

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Some promising advancement areas for modelling and simulation in:

1. Science, methodology, and technology of M&S
2. Trustworthiness, reliability, and quality in M&S
3. Application areas
4. Consolidation and dissemination of M&S knowledge
5. M&S professionalism

1. Science, methodology, & technology of M&S

- **Event-based modelling** (DEVS)
  & its synergies with other modelling formalisms,
  e.g., X-machines
- **Multimodels** or **multiaspect models** (to encapsulate a set of closely related modules of a model)
  - *Normally* only one model module can be active at a given time.
  - During simulation, transition conditions can be monitored for switching from a module to another one.

Variable structure models:

(trajectory simulation & structural simulation)

to study the evolution of the structure of a system, e.g., crystal growth, growth of plants expressed as L-systems, cellular automata, variable-boundary system simulation, etc.

- In *adaptive system simulation*, the system may need to change its structure (adopt itself) to satisfy its goal of existence.

- *Evolutionary system studies* require mutations of the simulation models.

Multisimulation:

to experiment with several aspects of reality simultaneously.

Under *emerging conditions*, one can add *emerging* successor *models* to existing models to explore behavior of alternative system models.

Automation of design of experiments:

Simulation environments can be enhanced by having experimental design abilities.

Then a shell can apply the experimental design to activate the simulation with appropriate values of decision parameters and to observe the outcomes.

Later an analysis module can perform the statistical analysis to advise the user.

1. Science, methodology, & technology of M&S

Holonic agent simulation:

*A **holonic system** is composed of autonomous entities (called holons) that can deliberately reduce their autonomy, when need arise, to collectively achieve a goal.*

A *holonic agent* is a multi-agent system where each agent (called a holon) acts with deliberately reduced autonomy to assure harmony in its cooperation, in order to collectively achieve a common goal.

Holonic agent simulation can be the basis for application areas involving cooperation, conflict management, and peace support operations.

1. Science, methodology, & technology of M&S

Specification languages and environments for interoperability:

Interoperability is a very important and desirable feature to integrate several simulation studies –each called a federate– into a federation.

Maintaining specifications **instead of the code** would be much more cost effective; furthermore, it can also allow, symbolic processing of the specifications of models, experiments, and parameters to have computer-aided validation and verification.

2. Trustworthiness, reliability, & quality in M&S

Built-in reliability prior to validation and verification:

Ways to achieve reliability during the specification phase of modelling and simulation would be very beneficial.

Validation and verification based on specification of simulation studies can be more effective than validation and verification based on simulation programs.

2. Trustworthiness, reliability, & quality in M&S

Proper documentation of simulation studies:

Proper documentation of modelling and simulation studies, including clarification of several assumptions, may be helpful in validation and verification as well as for their proper use and reuse.

2. Trustworthiness, reliability, & quality in M&S

Reuse libraries:

Establishment of reuse libraries can be beneficial for organizations which use large number of simulations. They can benefit:

(1) by cutting cost,

(2) by saving time (by not reimplementing modules which already exist and by performing validation/verification studies only once), and

(3) by easing upgrading process (upgrade of a reused module can be shared with all installations using the same software module).

2. Trustworthiness, reliability, & quality in M&S

Taming and monitoring software agents:

One of the characteristics of agents is autonomy. However, full autonomy of agents may not assure their trustworthiness.

There are two challenges:

First, *built-in trustworthiness* which requires the limitation of the autonomy of agents while building them.

Second, *defensive trustworthiness* which requires, in an agent-based computation environment, monitoring and even licensing of agents.

3. Application areas

Human behavior and societal systems:

Understanding human behavior is essential for several studies.

There are already several human behavior and societal system simulation studies.

However, many more are warranted.

3. Application areas

Enhancement of decision making abilities for cooperation:

Zero-sum games: **competition**

Non-zero sum games: **cooperation**

Simulation can be useful in teaching the value and practice of cooperation.

3. Application areas

Enhancement of decision making abilities for conflict management:

Conflict management, including conflict avoidance and conflict resolution is an important ability.

It might be beneficial to increase use of simulation to enhance the decision making abilities for conflict management.

3. Application areas

Enhancement of decision making abilities for peace support / peace assurance:

There is a plethora of war gaming simulations.

In addition to them, it would be highly desirable to have peace support / peace assurance simulations to be used for the enhancement of the relevant decision making abilities of the concerned.

3. Application areas

Training systems with learning abilities:

It might be interesting to explore use of exploratory simulation in machine learning, to allow the agents to learn in a richer learning environment.

4. Consolidation & dissemination of M&S knowledge

Systematization of the body of knowledge:

The need is already been expressed.

A unified view will be useful

4. Consolidation & dissemination of M&S knowledge

Dictionary of terms

An authoritative dictionary of modelling and simulation would be very desirable to provide crisp definitions.

Otherwise the following type of definitions may be used: "Simulation: An experiment that models a real-life situation."

4. Consolidation & dissemination of M&S knowledge

Electronic textbook:

Examples:

- The Electronic Statistics Textbook
- The Internet Encyclopedia of Philosophy
- On-line mathematics textbooks

e-text(s) can display more knowledge then originally stored in them by exploring knowledge generation features of simulation models.

4. Consolidation & dissemination of M&S knowledge

Dissemination of knowledge:

Electronic newsletters of SCS and SCS Europe fulfill very useful functions. Conferences page of EUROSIM is a rich list of conferences.

However, another electronic dissemination mechanism used for software engineering (SEWORLD) can be a model for dissemination of modelling and simulation events.

4. Consolidation & dissemination of M&S knowledge

Graduate curriculum development:

An ACM style graduate curriculum in M&S would be very useful, for individual educational institutions as well as for their cooperation (student exchange and credit transfers can be much simpler).

Several academic institutions and centers of the McLeod Institute for Simulation Sciences (MISS) can use such a curriculum.

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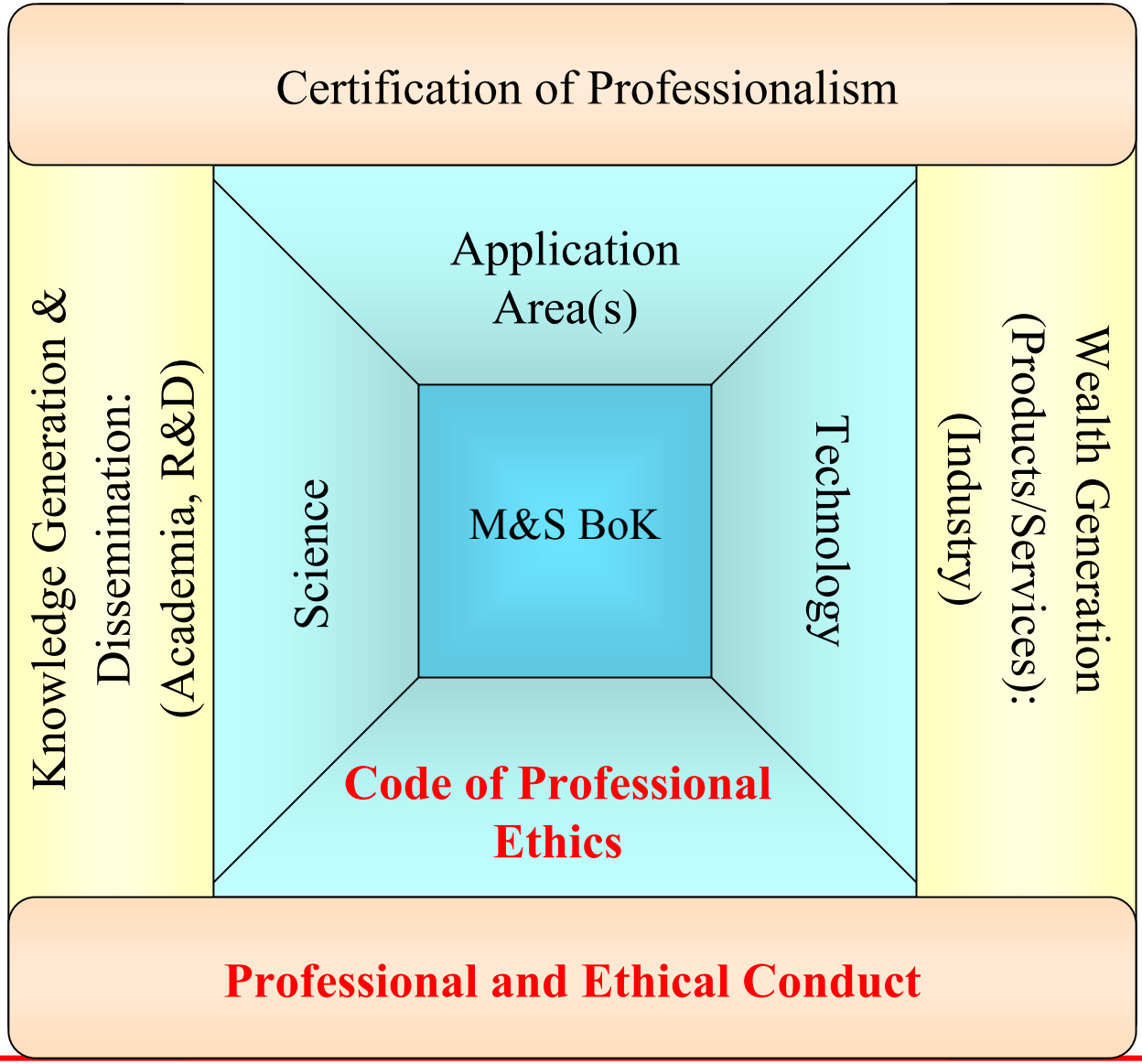
3 Aspects of Professionalism in M&S:



Knowledge:

To solve problems:
- M&S BoK
- Science
- Technology
- Application Area(s)

How to solve them (behavior):
- Code of Professional Ethics

Activities:
- Knowledge Generation and Dissemination: (Academia, R&D)
- Wealth Generation (Products/Services): (Industry)

Monitoring:
- Professional and Ethical Conduct
- Certification of Professionalism

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- **Responsible**:

  Ability to fulfil one's moral obligations;

  it is an ideal of character, a virtue.

  Only maturity may imply responsibility.

- **Accountable**:

  Being required to answer for one's actions.

Position Statement:

- The growing importance and the scope of application areas of modelling and simulation oblige us to re-examine our field and reflect upon whether or not those who are involved in any aspect of it have any responsibility.

"The unexamined life is not worth living."
Socrates (469-399 BC)

And "life" may well cover professional societies and professions as well.

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- **Ethic** *is a* set of principles of right conduct.

- **Ethics** refers to the general nature of morals and the specific moral choices to be made by a person.

- **Professional ethics**,

  i.e., the rules or standards governing the conduct of a person or the members of a profession.

  The terms medical ethics and business ethics are used similarly.

Ethics and simulation – ***A personal normative view***:

- Ethics in simulation **should be raised** to a visible status.

  (Or justifications should be given why while so many other professions are subscribing to codes of ethics, ethics is not mentioned in simulation studies.)

If our activities have no (serious) implications to others, then

it does not matter whether or not we should feel responsible towards them or we should be held accountable.

If simulation has no (serious) implications to others, then

it does not matter whether or not simulationists should feel responsible towards them or should be held accountable.

Code of professional ethics for simulationists:

Simulation is one of the few professions which does not have a code of professional ethics.

This fact can be interpreted in several ways:

(1) The works of simulationists do not have serious impacts to others; hence ethical considerations are not warranted.

(2) The customers/users of simulation studies are not aware of their rights.

(3) It might be the right time to develop, adopt, and practice a code of ethics.

"What you don't want done to yourself, don't do to others." Confucius (551-479) BC)

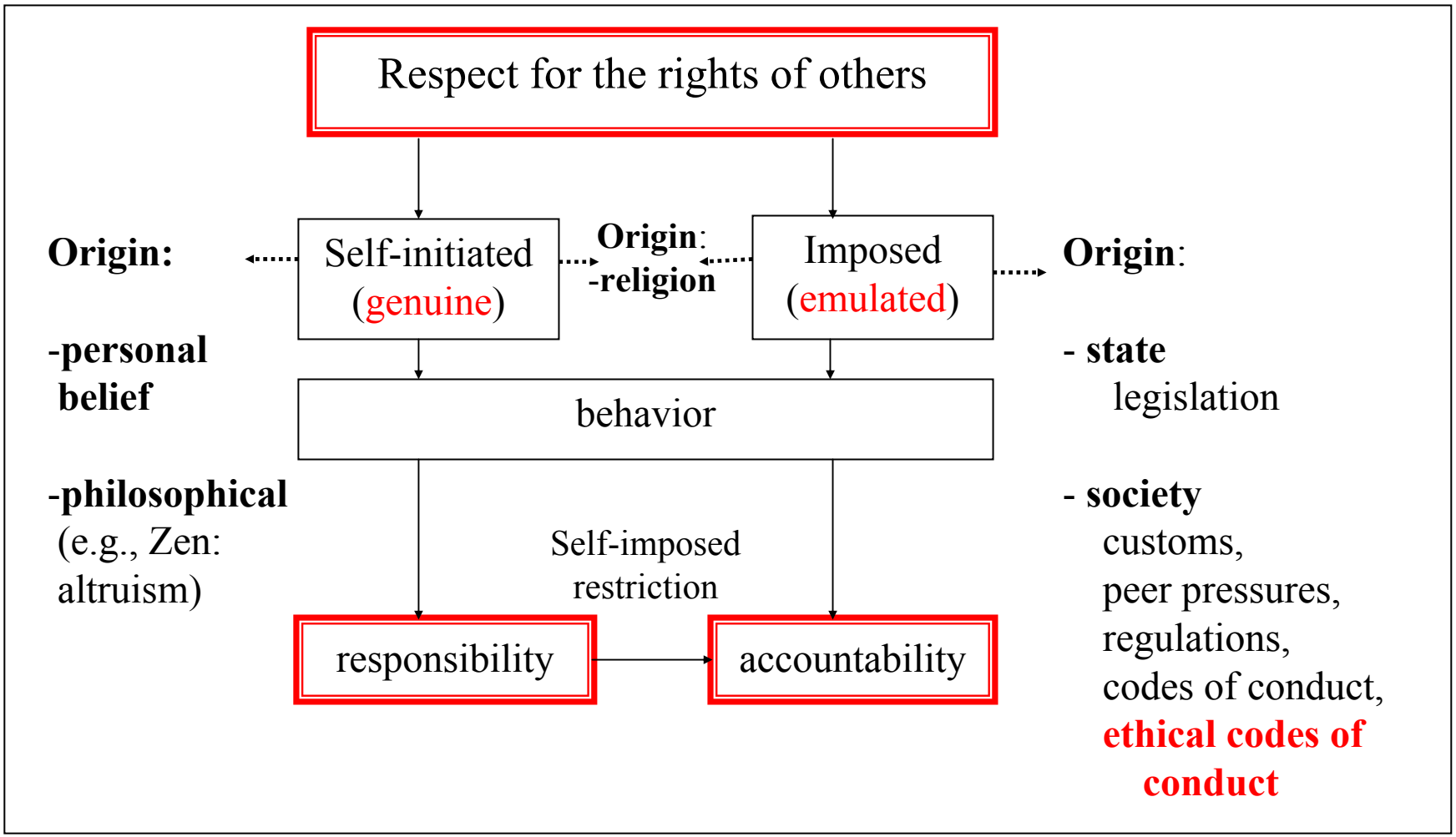
The respect for the rights of others:

- is the essence of right conduct.
- It is also a fundamental concept in civilized societies, essential for the regulation of the social dynamics in order to sustain the civilization.

Also:

No business, how lucrative it is, can be sustained if one looses the trust of the stakeholders.

The origins for the respect for the rights of others:



- A site:

http://www.site.uottawa.ca/~oren/SCS_Ethics/ethics.htm

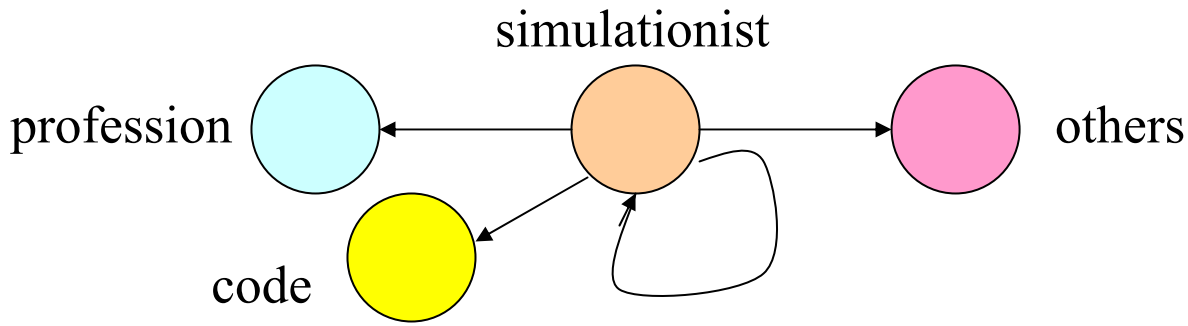
- Why it is time for us, the simulationists to have a code of ethics?

Simulation has thousands of applications; and,

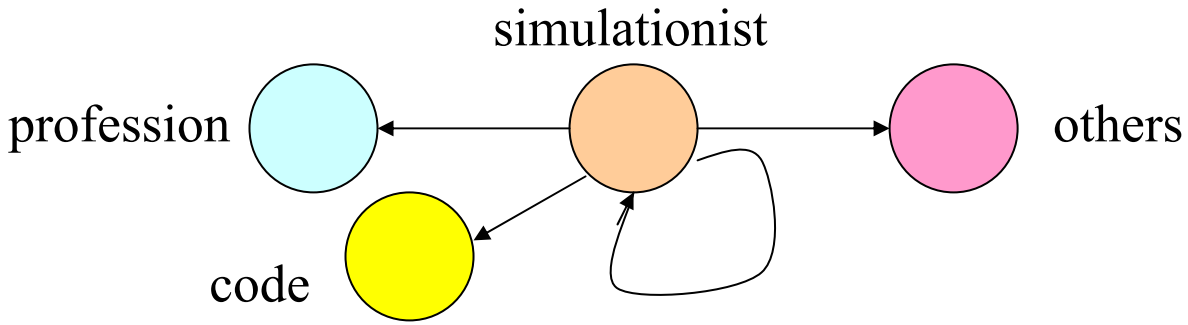
simulation studies/products ***can affect*** ***people*** *as well as the* ***environment*** *in many ways*.

Or, what we do can have important consequences! As mature members of a mature profession, we can act proactively to assuming our responsability and accountability.

Responsibilities of simulationists to:



5 Areas of the Code:



1. Personal development and the profession (7)
2. Professional competence (8)
3. Trustworthiness (4)
4. Property rights and due credit (4)
5. Compliance with the code (4)

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1. Personal development and the profession:

As a simulationist I will:

1.1 Acquire and maintain professional competence and attitude.

1.2 Treat fairly employees, clients, users, colleagues, and employers.

1.3 Encourage and support new entrants to the profession.

1. Personal development and the profession:

As a simulationist I will:

1.4 Support fellow practitioners and members of other professions who are engaged in modelling and simulation.

1.5 Assists colleagues to achieve reliable results.

1.6 Promote the reliable and credible use of modelling and simulation.

1.7 Promote the modelling and simulation profession; e.g., advance public knowledge and appreciation of modelling and simulation and clarify and counter

false or misleading statements.

2. Professional competence:

As a simulationist I will:

2.1 Assure product and/or service quality by the use of proper methodologies and technologies.

2.2 Seek, utilize, and provide critical professional review.

2.3 Recommend and stipulate proper and achievable goals for any project.

2.4 Document simulation studies and/or systems comprehensibly and accurately to authorized parties.

2. Professional competence:

As a simulationist I will:

2.5 Provide full disclosure of system design assumptions and known limitations and problems to authorized parties.

2.6 Be explicit and unequivocal about the conditions of applicability of specific models and associated simulation results.

2.7 Caution against acceptance of modelling and simulation results when there is insufficient evidence of thorough validation and verification.

2.8 Assure thorough and unbiased interpretations and evaluations of the results of modelling and simulation studies.

3. Trustworthiness:

As a simulationist I will:

3.1 Be honest about any circumstances that might lead to conflict of interest.

3.2 Honor contracts, agreements, and assigned responsibilities and accountabilities.

3.3 Help develop an organizational environment that is supportive of ethical behavior.

3.4 Support studies which will not harm humans (current and future generations) as well as environment.

4. Property rights and due credit:

As a simulationist I will:

4.1 Give full acknowledgement to the contributions of others.

4.2 Give proper credit for intellectual property.

4.3 Honor property rights including copyrights and patents.

4.4 Honor privacy rights of individuals and organizations as well as confidentiality of the relevant data and knowledge.

5. Compliance with the code:

As a simulationist I will:

5.1 Adhere to this code and encourage other simulationists to adhere to it.

5.2 Treat violations of this code as inconsistent with being a simulationist.

5.3 Seek advice from professional colleagues when faced with an ethical dilemma in modelling and simulation activities.

5.4 Advise any professional society which supports this code of desirable updates.

We have seen: Modeling & Simulation

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A Normative View as a Conclusion:

Hope that in our continuing journey to professionalism you would support:

- The view that M&S is so important that there is a need for ethical professional conduct.
- This specific Code of Professional Ethics.
- The adoption of this Code by your professional society.

No progress is ever possible by keeping the status quo!

Emulate nature; keep blooming!