# Responsibility, Ethics, and Simulation

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*This paper consists of three parts: (1) In the introduction, basic terminology is reviewed; the relationship of ethics, philosophy, and civilization is given; respect for the rights of others is introduced as the essence of social order, one of the elements of civilization; and the need for courage in ethics is mentioned. (2) In the second part, ethics in topics other than but closely related to simulation is mentioned. In particular, some Websites are cited which refer to ethical issues in science, engineering, business, computerization, software engineering, AI, software agents, the Internet, and defense industries. (3) The last part, simulation and ethics, covers the following issues: Should there be a code of ethics for simulation? Where to start to develop a code of ethic for simulation? Whose responsibility? And responsibility to whom?*

> *"We all think electricity is entirely governed by natural laws, and yet we think it is rational to put up lightning conductors. Well, I should say that an ethic is, as it were, a lightning conductor for human passions, to enable them within a deterministic world to work in a way that produces a minimum of disaster."*—Russell, *Spinosa's Ethics* [1]

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## 1. Introduction—Why Ethics?

There is a plethora of documents on ethics. For example, in January 2000, a search on the Internet using the search engine Magellan with "ethics" as the keyword points out over 180,000 records. Similarly, a search of books—on *Amazon.com*—ends up with over 14,000 books. In contrast with this abundance, there are no books on ethics in modelling and simulation in my private library, where I have well over 500 books and proceedings on modelling and simulation. This lack (or, in case I missed the reference(s), the rarity) of publications raises two questions: "Is ethics unimportant in modelling and simulation studies?" and "Should there be a code of ethics in modelling and simulation?" This article explores these questions.

### *1.1 Terminology*

The word "ethics" is derived from the Greek word *êthikos* with the root *êthos*, which means manners and customs. "Moral" is derived from the Latin word *moralis*, which also means manners and customs. Hence, though there are shades of difference, the terms ethics and moral are used as synonyms. There are several aspects:

- *Ethics* or *ethical philosophy* is a branch of philosophy that studies the principles of what is right or wrong in human manners or human behavior.
- *Ethic* denotes a system of ethics.
- *Ethical* means dealing with ethics.
- *Ethical standard* stands for conforming with accepted standards of good behavior.
- The terms *ethics* and *morality* are used to mean *standard for ethical or moral behavior*.
- Sometimes, the terms *ethics* and *morality* are used to mean *code of behavior* or code of conduct. However, not every code of behavior is morally or ethically justified. For example, a gang may have a code of conduct for their operation; however, their conduct may not be ethical for the society.

### *1.2 Ethics, Philosophy, and Civilization*

Philosophy deals with three fundamental issues: existence, knowledge and values. The study of values includes axiology and aesthetics. The term "axiology" comes from the Greek *axia* (value) and *logos* (study). Axiology consists of the study of ethical values.

Ethics is one of the fundamental issues of philosophy. In addition, *ethics or morality is one of the pillars of civilization.* For example, in his eleven-volume history of civilization, Durant defines civilization and its elements as follows:

> *"Civilization is social order promoting cultural creation. Four elements constitute it: economic provision, political organization, moral traditions, and the pursuit of knowledge and the arts."—The Story of Civilization* [2]

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He elaborates on the moral elements of civilization in Chapter 4 and especially stresses the need for order in a society to nurture and sustain civilization. The degree of civility of a society depends on the balance of the rights and privileges of individuals and groups that exist in the society [2].

*1.3 Essence of Social Order*

Human behavior towards others may be categorized in two ways according to whether or not behavior takes into account respect for the rights of others. Therefore, one can identify (1) behavior by respecting the rights of other (which leads to ethical conduct) and (2) behavior by not respecting the rights of others (which leads to unethical conduct).

Respect for the rights of others (mainly humans, but not excluding animals and environment) is the essence of social, humane, and ecological order and may be self-initiated or imposed (Figure 1).

When the respect for the rights of others is self-initiated, it is genuine. The origins of genuine respect for the rights of others can be personal belief including a philosophical point of view. For example, in Zen, altruism is considered a virtue [3]. The behavior of an individual with genuine respect for the rights of others involves responsibility. Only maturity may imply responsibility. A *responsible behavior* is the ability to fulfill one's moral obligations. By a self-imposed restriction, responsibility implies accountability. *Accountable behavior* necessitates being required to answer for one's actions. However, as a source of confusion, sometimes the term responsible is used to mean accountable.

In a society, respect for the rights of others can be imposed by several mechanisms to guarantee its existence. In this case, the respect is emulated as opposed to being genuine. However, from a pragmatic point of view, both genuine and emulated respects for the rights of others are behaviorally equivalent. An individual who is committed to emulated respect for the rights of others is accountable. The origins of imposed—or emulated—respect for the rights of others can be religion, state or society. Major religions promote respect for the rights of others, states provide it by jurisdictions, and societies have developed customs, pressures, regulations and codes of conduct, including ethical codes of conduct.

*1.4 Ethics and Courage*

The following quotation from Russell explains the reasons for which courage is sometimes needed for ethical conduct, especially when accepted codes of conduct of societies need to be questioned.

> *"I come now to the question of personal ethics, as opposed to the question of social and political institutions. No man is wholly free, and no man is wholly slave. To the extend to which a man has freedom, he needs a personal morality to guide his conduct. There are some who would say that a man need only obey the accepted moral code of his community. But I do not think any student of anthropology could be content with this answer. Such practices as cannibalism, human sacrifice, and head hunting have died out as a result of moral protests against conventional moral opinion. If a man seriously desires to live the best life that opens to him, he must learn to be critical of the tribal customs and tribal beliefs that are generally accepted among his neighbours."*
> *—Authority and the Individual* [4].

## 2. Ethics in Topics other than Simulation

The reason for covering this topic in this article is to point out the existence of professional codes of ethics in domains that are relevant to simulation as well.

Although there are several definitions of simulation, it is better to adopt one that is applicable to any type of it in any application domain. Hence, the following definition is used here: *simulation* is goal-driven experimentation with dynamic models.

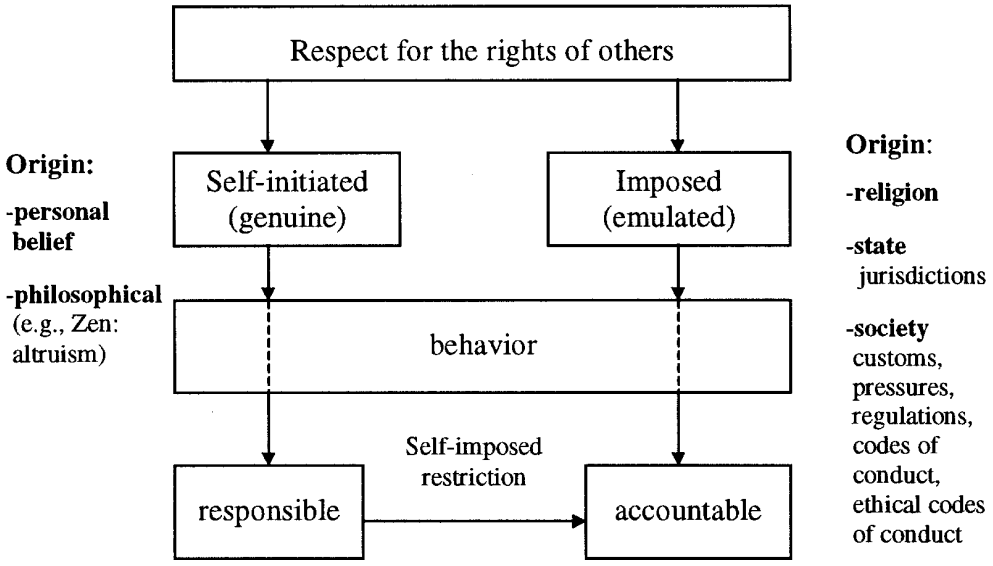


**Figure 1**. Origin of respect for the rights of others

Simulation is used for several reasons in different types of studies. In analysis problems, simulation is used in fundamental *science* to have insight to (i.e., understanding of) natural phenomena. Continuous simulation is an integral part of design or *engineering studies*. Discrete simulation is involved with *business applications*. Simulation requires *computerization* and is involved with *software engineering*. *Artificial intelligence* applications in simulation software and in modelling and simulation are aspects of AI relevant to simulation. *Software agents* that can act autonomously are already part of simulation systems. Internet simulation is a domain that ties simulation and the *Internet* where the computational platform can be a local computer, a local network or the whole network and the associated computers. Furthermore, simulation is used in hundreds of application areas including *defense* applications. Therefore, brief pointers to ethical issues in science and engineering, business, computers, software engineering, artificial intelligence, software agents, the Internet, and defense will be given below. This list is not meant to be exhaustive; it is rather a collection of samples in the respective areas.

A collection of over 50 official codes of ethics issued by 45 associations in business, health, and law is given in [5].

### *2.1 Ethics in Science and Engineering*

The online Ethics Center for Engineering and Science is at *http://www.onlineethics.org/* [6]. The site of the National Institute for Engineering Ethic is at *http://www.niee.org/* [7]. The cited sites also have pointers to many relevant aspects of ethics in science and engineering.

### *2.2 Business Ethics*

DePaul's Institute for Business and Professional Ethics offers codes of conduct of several businesses as well as pointers to relevant references [8]. An in-depth reference for several aspects of business ethics as well as a valuable source of Web references is Hartman [9].

### *2.3 Ethics in Computerization and in Software Engineering*

Codes of conduct in computerization from around the world are given at *http://courses.cs.vt.edu/~cs36004/lib/WorldCodes/WorldCodes.html* [10]. A code of ethics, jointly approved by ACM and IEEE-CS as the standard for teaching and practicing software engineering, is given at *http://www-cs.etsu.edu/seeri/secode.htm* [11]. The code consists of the following sections: public, client and employer, product, judgement, management, profession, colleagues, and self.

### *2.4 Ethics in Artificial Intelligence and Software Agents*

During the Falkland Islands War, the inability to identify an incoming missile as an enemy missile by the expert system in an Argentine military ship was the reason for the destruction of the ship. If the rules of the expert system were properly audited, one could have properly updated the rules. "Who is responsible in AI-based systems?" is an important question to be properly answered; otherwise, such systems may be vulnerable. The impact of agents on communications and ethics was discussed in a workshop held in Dublin in July 1998 [12].

### *2.5 Ethics in the Internet*

The topic is discussed by Cheong [13]. There are two aspects: (1) Internet etiquette and crime on the Internet, and (2) ethical issues for the developers of Internet agents and Internet tools. A code of ethics for Webmasters is offered at *http://www.iwanet.org/about/pro-ethics.html* [14]. Related standards are given at *http://www.iwanet.org/about/standards.html* [15]. Even hackers have a code of ethics (*http://www.high-density.com/glossary/glossary-h.htm*) [16].

### *2.6 Ethics in Defense Industries*

The site of the Defense Industry Initiative, a consortium of U.S. Defense industry contractors on business ethics and conduct is at *http://www.dii.org/* [17].

## 3. Simulation and Ethics

### *3.1 Should There Be a Code of Ethics for Simulation?*

From a pragmatic point of view, we have to note that, if our activities have no serious implications to others (humans, animals and environment), it does not matter whether or not we should feel responsible towards them or we should be held accountable. Accordingly, 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. Therefore, the question of whether or not ethics in simulation should be considered can be reduced to whether or not simulation can have serious implications on others.

Simulation is used to support important policies and decisions. For example, in nuclear fuel waste management systems, simulation is used to study long-term behavior (even several millenia) of nuclear fuel waste. Simulation of safety-critical systems is one of the important application areas of simulation. Currently, simulation is also used in simulation-based acquisition as well as simulation-based prototyping, affecting millions of dollars of investments. Simulation has the potential of surpassing its own abilities of being an off-line decision making tool to also being an on-line decision support tool for complex and important problems.

The existence of several validation, verification, and accreditation (VV&A) techniques and tools also attest to the importance of the implications of simulation [18]. In VV&A studies, it is customary to refer to the reliability of the simulation team. However, what is indeed needed for the simulation profession is a well defined code of ethics that is the missing link in VV&A studies. Allegiance to a well defined code of ethics would ease establishment of the credibility of simulationists as individuals or as groups and then we hope that decision makers can take simulation as a thrustworthy tool.

As serious and dedicated simulationists, we should ask ourselves some pertinent questions, such as the following: "Why is ethics not considered in VV&A studies?" and "Is ethics a marginal issue in VV&A studies?" Unless one finds convincing evidence on the marginality of ethics in modelling and simulation, serious simulationists should pursue the issue and a code of professional ethics should be developed and used. It seems to me that what Socrates said for individuals, "The unexamined

life is not worth living," is also applicable to fields of activities as well, and the time is ripe for simulation, as a mature field, to start questioning the bases of its impact to others.

*3.2 Where to Start to Develop a Code of Ethics for Simulation?*

If we were convinced of the value of consideration of ethics in simulation studies, the next question would be how to develop a professional code of ethics for simulation.

An international association (such as SCSI—the Society for Computer Simulation International) dedicated to simulation may form a working group to be active in developing such a professional code of ethics. However, since defense applications of simulation are of primordial importance, it would not be surprising if appropriate studies are initiated within the Defense Modelling and Simulation community to follow the example of the Defense Industry Initiative [17]. Ideally, several groups may work together to cast light on different aspects of the ethical problems in modelling and simulation.

In a categorization of the assessment of the elements of modelling and simulation studies, the place of ethical issues in modelling and simulation is pointed out [19]. As seen in Table 1, there are two groups of assessments, which are descriptive and normative assessments.

*Descriptive assessment* of an element of modelling and simulation study is its evaluation with respect to the value-free rules to represent it. It consists of syntactical, morphological, and semantic assessments.

*Normative assessment* of an element of modelling and simulation study is its evaluation with respect to some norms of a value system which can be pragmatic or ethical.

*Pragmatic assessment* of an element of modelling and simulation study is its evaluation with respect to practical results such as implementability, usability, usefulness, clarity, comprehensibility, or cost effectiveness.

*Ethical assessment* of an element of modelling and simulation study is its evaluation with respect to a set of moral norms.

*3.3 Whose Responsibility?*

The term responsibility evokes two concepts: whose responsibility? And responsibility to whom? The answer to the first question is "responsibility of simulationists." Hence, so far as responsibility is concerned, a broad view of the term simulationist has to be considered to encompass responsibility of all those concerned with different aspects of simulation.

**Table 1**. Types of assessments of elements of modelling and simulation studies

| | |
|---|---|
| Descriptive assessment | Syntactical assessment |
| | Morphological assessment |
| | Semantic assessment |
| Normative assessment | Pragmatic assessment |
| | Ethical assessment |

A simulationist is *somebody* who is involved, full-time or part-time, with at least one of the following activities:

- *Collects and/or specifies data* to be used for/by simulation models. (In analysis problems, by designing experiments, by performing instrumentation, calibration, a.s.o. In design problems, by providing explicit assumptions, by allowing implicit assumptions, and by formulating and certifying specifications.)
- *Develops models* to be used for simulation purposes.
- *Engages in VV&A* (validation, verification, and accreditation) *studies.*
- *Performs simulation studies*, i.e., specifies simulation problems, causes generation of model behavior and performs analysis/interpretation of the generated model behavior.
- *Formulates* (specific or policy) *solutions* to problems based on simulation.
- *Develops simulation software*, simulation software generators, or simulation tools.
- *Manages* simulation projects (engineering or administrative management).
- *Advertises and/or markets* simulation products and/or services.
- *Maintains* simulation products and/or services.
- *Advises* other simulationists.
- *Promotes simulation-based solutions* to important problems.
- *Advances simulation technology*.
- *Advances simulation methodology and/or theory*.

An in-depth and detailed categorization of the elements of modelling and simulation studies—given by Sheng, et al. [20] and based on a previous categorization by Ören [21]—for the purpose of their assessments can be useful in determining which elements of simulation studies might benefit from ethical considerations.

Finally, in developing a code of ethics for modelling and simulation, revisiting the relationship of ethical considerations in simulation and related fields might be useful:

- For non-academic applications, simulation is business and most of the ethical issues in business might be applicable to "simulation business."
- For scientific and engineering applications, simulation models may entail considerations of codes of ethics in science and engineering.
- Simulation is a computerized application and its computerization is based on software engineering, Internet, and artificial intelligence applications in software engineering such as software agents, mobile agents, and knowledge-based systems. Therefore, some parts of professional ethics in computerization, the Internet, software engineering, and agents

are also applicable in modelling and simulation. Furthermore, responsibility and accountability of agents—especially mobile agents—and expert systems should not be left unchallenged.

- When the abilities of *non-human* autonomous/non-autonomous *agents* will be advanced to perform *some* of the activities of human simulationists, their responsibilities in respective area(s) should also be questioned. At this level, in AI-directed simulation and in agent-directed simulation, the essential question to be asked will be: who should be accountable? A multi-agent system, an agency of avatars, the person who implements them, or the person who approves the delegation of responsibility to an agent system or to even an expert system. Delegation of responsibility with blind confidence to non-human decision makers may be questioned with the maturity of artificial intelligence in general computer-aided problem solving as well as in simulation. Similarly, delegation of responsibility to human simulationists may also be questioned for simulation studies with important implications.

*3.4 Responsibility to Whom?*

Responsibility of a simulationist has to be considered with respect to the public, client, employer, colleagues, profession, and self. Some suggested codes are listed below:

- Responsibility of a simulationist with respect to the the *public*:
  - A simulationist shall act consistently with the public interest.
  - A simulationist shall promote the use of simulation to better human existence.
- Responsibility of a simulationist with respect to *client* (a simulation client is a person, company, or agent which purchases, leases, or rents a simulation product, simulation service, or a simulation-based advice):
  - A simulationist shall act in a manner that is in the best interest of the client. This responsibility shall be in accord with the public interest.
  - A simulationist shall deliver/maintain a simulation product and/or services to solve the problem in the most trusthworty way. This includes usefulness, i.e., fitness for purpose(s) as well as meeting the highest professional standards.
- Responsibility of a simulationist with respect to the *employer*:
  - A simulationist shall act in a manner that is in the best interest of the employer, provided that the activities are in alliance with the best interest of the public and the client.
  - A simulationist shall respect the intellectual property rights of her/his current and/or past employers.
- Responsibility of a simulationist with respect to the colleagues:
  - A simulationist shall be fair and supportive of her/his colleagues.
- Responsibility of a simulationist with respect to the *profession*:
  - A simulationist shall advance the integrity and reputation of the simulation profession consistent with the public interest.
  - A simulationist shall apply simulation technology in the most appropriate way and shall not force simulation or any type of it as a Procrustean bed.
  - A simulationist shall share her/his experience and knowledge to advance the simulation profession; and this will be in concert with her/his employer's and client's interest.
- Responsibility of a simulationist with respect to *self*:
  - A simulationist shall continue enhancing her/his abilities to have appropriate vision and knowledge to conceive problems from a broad perspective and to apply them for the solution of simulation problems.

At this point, I reminisce the well known poem of Rudyard Kipling titled "If." Our field, simulation, has achieved a very important and distinct position as a scientific decision making tool due to the accumulated contributions of several great simulationists. When and if the concept of self-imposed reponsibility is widely accepted by simulationists, a set of conditional statements may also be developed, a la Kipling, to distinguish truly great simulationists among already existing very good ones.

## 4. Conclusion

Simulation and ethics can enhance each other. Simulation, as goal-directed experimentation with dynamic models, can be used in assessing ethical problems in several professional situations [22]. Ethics, in turn, should be considered at several stages of simulation studies, except maybe in situations where unethical conduct has no important effect. It is hoped that at the beginning of the 21st century, the simulation profession will prove its maturity by developing a code of ethics for modelling and simulation, by promoting it, and by assuring adherance to it.

Credibility of simulation studies as well as credibility of simulationists are important concepts. This article is written to promote the credibility and integrity of simulation as a field itself. The views are the author's (except where bibliographic references are given) and do not represent his current or previous employers.

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