

# A Subject-Machine-Object Interaction Reference Model and its Application in Electronic Publishing

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## Abstract

The necessity of a subject-machine-object interaction (SMOI) reference model and its application in electronic publishing of the objects of our culture is considered. The components of such a model are listed. The proposed relatively full Reference Model of the SMOI components allows designers to divide the interaction task into subtasks more easily. It allows an easier choice of standardisation fields and conversion of an Object's models description and presentation.

**Keywords:** subject-machine-object interaction, reference model, integrated communication channel

## Introduction

We can use at least three methods of electronic publication of a material sculpture: 1. To publish its *digital photography*; 2. To publish a *video film* of the sculpture; 3. To publish a *spatial (3D) computer model* of the sculpture. The model can be prepared using suitable graphic software and must include the optical characteristics of the sculpture's surface. The observation circumstances may be chosen by the users, individually and interactively. They include photographic (optical) circumstances, measurements possibilities (distance, colour, etc.) and, possibly, other sense requirements (sound, touch, taste, and smell). Obviously, this electronic publishing method is closest to the author of the sculpture's spatial conception. The three methods can be used in any combination. The first two are well developed in electronic publishing, but the third is used predominantly in remote robot control, in telemedicine and computer simulation. Following relatively new developments, we should expect the emerging of distant site seeing and virtual visits to real museums, with remotely controlled lighting and sensing. Thus, our immediate task is the development of a common methodology of personalized multimodal, distant and interactive work with maximal realistic computer models of the objects of our culture.

## Objective

To propose a usable reference model of SMOI system for the purposes of system analysis and design. Human-machine/object interaction concepts are targeted in EU 6FP IST Work Programme 2002-2006, "Ergonomics and Biomechanics of the system Human-Machine-Environment", in item 2.3.4 of the Main Research Directions of the Russian Academy of Sciences [[http://www.prn.ru/pdf/pril\\_post\\_0107.pdf](http://www.prn.ru/pdf/pril_post_0107.pdf) (20.10.05)] and many other research programmes, but there is no common reference model of this interaction.

## Results

A machine is any entity capable of:

1. performing the Subject's commands for changing the Object's internal and/or external properties;
2. delivering information about the Object's states and its own to the Subject.

The machine may include three components: Local and remote submachines and a telecommunication subsystem connecting the two submachines. The three components may comprise powerful computers. The investigated SMOI system is considered as consisting of 14 functional components: four (partly) controlled main components (No. 01,

05, 09 and 13 in the list below); three interaction interfaces (No 03, 07, and 11) and seven different environments (No. 02, 04, 06, 08, 10, 12 and 14).

The components of the *proposed reference model* are: 01. *Object*. An Object is any entity in the field of the Subject's interests and undergoing the Remote Machine's actions. The Object (possibly a complex computer model of a real or imaginary object) may have its own behaviour and interaction with its environment, but is not in a position to influence the Subject non-informational (it is a remote entity). The Object undergoes actions from its Environment as well as the Machine's effectors. The Object creates reactions reflecting external actions and its own internal state and behaviour; 02. *Environment of the Object* (not controlled and usually not observed by the Remote Machine, but possibly influencing the Object's state and behaviour); 03. *Machine–Object Interface*. Consists of the Machine's effectors and sensors and Machine–Object Interaction Media; 04. *Environment of the Machine–Object Interface*. It may cause noise and distortions in the Machine–Object Interaction. Sometimes the Environment is observed and taken into account (e.g., external light intensity and colour temperature); 05. *Remote Machine*. The sensors and effectors of the Remote Machine are controlled. Their position, orientation and actions are indivisible parts of the description of the Object's Property parameters. The Remote Machine receives the Subject's commands for observation and changes the Object's environment and reactions. Results of the Remote Machine's work are a model of the Object (including its environment) and a meta-model (including meta-data and model's description). The Remote Machine sends control information of its own state to the Subject also. The Remote Machine may be divided into an Interactor (there are 341,000 documents containing this word, by Google) with the Object and Communicator (with the Local Machine); 06. *Environment of the Remote Machine*. It is not involved in interaction directly and is not controlled by the Remote Machine usually, but may influence its state and behaviour (e.g., power supply, temperature, vibration, noise, etc.); 07. *Telecommunication Interface* (Remote Machine–Local Machine Interface); 08. *Environment of the Telecommunication Interface* (may cause noise and distortions in the communication). 09. *Local Machine*. The Local Machine may be divided into an Interactor (with the Subject) and a Communicator (with the Remote Machine); 10. *Local Machine Environment* (see 06 for an analogy); 11. *Subject–Local Machine Interface*. It consists of the Local Machine's and the Subject's effectors and sensors and Local Machine–Subject Interaction Media. This Interface may be reduced to a computer program interface, if the Subject is a computer program (see 13); 12. *Environment of the Subject–Local Machine Interface* (see 04 for an analogy); 13. *Subject*. A Subject may be any entity (e.g., a human operator or a computer program) capable of handling an object through a machine. This definition of Subject reflects Internet searching by computer programs (usually called “robots”) and the definition of “user” by the International Telecommunication Union (see ITU-T Recommendation E.600); 14. *Environment of the Subject* (see 06 for an analogy).

## Conclusion

The main target of the considered SMOI processes, in the field of electronic publishing, is to create in the Subject's memory a model of a remote Object, including all important characteristics of the Object's behaviour. The proposed relatively full Reference Model of the SMOI components allows designers to divide the interaction task into subtasks more easily. It allows easier choice of standardisation fields and conversion of Object's models description and presentation. For example, an ancient manuscript with text and drawings may be stored in a standardized electronic form equally suitable for different presentations: visual, mechanical, with sound and/or speech for disabled people. In a good design, personal changes are only needed in the Local Machine Interactor.

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