Standardizing Simulations – "Uphill all the way!"

Wolfram Horstmann

Bielefeld University, PO-BOX 10 01 31, 33501 Bielefeld, Germany

Phone: 0(049) 521 106 5575, E-Mail: wolfram.horstmann@uni-bielefeld.de

Abstract (ENGLISH)

Simulations represent complex and dynamic knowledge by being inherently functional. Despite this extraordinary capability – not realized in any other medium – no widespread standards have prevailed. Considering the conceptual difficulty, the semantic variety and the specialization in complicated content the lack of standards is no surprise: The versatility of simulation takes a heavy toll on standardization! Moreover, the provision of inherent functionality necessitates that users decide what the simulation will be like and forces them to make the corresponding interventions. These active cognitive and behavioural processes inescapably introduce a human factor that cannot directly be included in standardization ventures. Since the logic of simulation is based on the human factor, it is concluded here that attempts to standardize simulations can only be successful if they focus on the human factor – a work that eventually implies enduring research and development processes.

Abstract (DEUTSCH)

TITEL: Der mühsame Weg zu Simulationsstandards

Simulationen können komplexes und dynamisches Wissen repräsentieren, weil sie inhärent funktional sind. Obwohl sie in dieser außergewöhnlichen Eigenschaft alle anderen Medien übertreffen, existieren noch keine verbreiteten Standards für Simulationen. Angesichts der konzeptuellen Schwierigkeit, der Bedeutungsvielfalt und der Spezialisierung auf komplizierte Inhalte ist dies jedoch keine Überraschung: Die Vielseitigkeit von Simulation hat ihren Preis! Hinzu kommt, dass die inhärente Funktionalität die Benutzer zwingt zu entscheiden, wohin die Simulation laufen soll und entsprechend in das Medium zu intervenieren. Die zwingende Notwendigkeit dieser aktiven kognitiven Prozesse und Handlungen führt einen menschlichen Faktor in die Simulation ein, der nicht direkt in einen Medienstandard integriert werden kann. Da darauf jedoch die Logik der Simulation aufbaut, steht und fällt der Erfolg von Standardisierungsinitiativen für Simulationen mit der adäquaten Berücksichtigung des menschlichen Faktors – und dies ist offenbar nur über anhaltende Forschungs- und Entwicklungsprozesse nachhaltig erreichbar.

Introduction

The venture of standardizing simulations shows a large gap between desire and reality. On the one hand nearly everyone concerned with media asserts a prominent role to simulations and claims to know what simulations are about (at least tacitly). On the other hand neither a common-sense nor a binding formal specification is within reach. A "save as …" button for simulations has been scarcely realized. Without standards, the development of simulation-specific formats, authoring tools, metadata, ordered databases, quality standards, evaluation guidelines or instructional designs is impeded.

A prominent illustration of the present situation is given by the Learning Object Metadata initiative IEEE-LOM (http://ltsc.ieee.org), probably the best known approach seeking to introduce classification standards ('metadata') for educational media: According to the LOM-Specification, simulations are conceived as a specific "Learning Resource Type". But beyond that, simulations just serve to exemplify learning objects showing an "active interactivity type", a "high interactivity level" and "high or low grades of semantic density". Hence, an unbiased reader of the LOM specification can take home the message that an important role of simulations is acknowledged. But apart from a characterization as 'something interactive' the conception of simulations is void.

One might object that the LOM just serves to classify media and, therefore, a broad conception is sufficient. In other words: Do we really need more specific standards? For answering this question, consider a teacher looking for usable simulations within the countless applets on the internet (e.g. simulations on the "travelling salesman", a famous formal problem asking for the optimal order to deliver goods to numerous recipients that is often mathematically solved by way of artificial neural networks). Suppose, his search yields about 100 different simulations (a minimalist estimation). Which one is the best? Which one to take for which instructional setting? Which one is evaluated? Thus, there is a huge resource but it is hard to utilize without more specific standards for simulations.

Serious efforts have been made in order to condense the issue of simulation. There are several attempts to provide classification systems for simulations (e.g. Schmucker, 1999; Fishwick, 1995) and countless Mark-Up Languages, but none of them did break through in a way that it could serve as a guideline in standardization ventures. Continuing research traditions on

simulations in psychology, education and artificial intelligence (see 2.3) have been successfully pursued for decades. But, obviously, they didn't flock together. Given all these efforts, why didn't emerge a common sense for simulations in a way that there is common sense, say, about what a film or a text is? At least some kind of common sense, obviously, would be the minimum demand for any standardization venture.

In sum, the way to simulation standards is definitely explored but in the present situation too many different paths sidetrack from a way straight ahead. Thus, rather than outlining yet another path, this text, in the first step, seeks factors that explain why the different paths do not effectively converge towards common sense. In the second step, it is attempted to peel out specific features that point the way towards the core of simulation. The third step previews how such core characteristics of simulations could be employed to yield a classification system that in turn could guide standardization ventures.

1 Impediments for Simulation Standards

Three major factors impeding the emergence of common-sense and standards are considered here: First, c*onceptual difficulty* arises from the simulation's characteristic to be inherently functional (that is to be organizational open) and from a non-trivial conceptual structure that encompasses three levels of meaning: simulandum, simulans and simulator (see Fig. 1). These difficulties are 'supported' by the closely related and no less complicated sub-concepts 'representation' and 'model'. As a result, multiple notions of what is meant by simulation in a given situation are possible. These different notions prepare the ground for the second impeding factor: *semantic variety.* At least five major accounts of simulation can be found when combing through scientific databases: 'social' often in the form of role plays (Heitzmann, 1973), 'gaming' (Crookall, 2001), 'device' as in cockpit simulations (Kieras & Bovair, 1983), 'model' (formal-mathematical) and 'cognitive' simulation (Johnson-Laird, 1980, 1983; Gentner & Stevens, 1983; Barsalou, 1999). Third, to top it all, simulations are specialized in bearing *complicated content*, i.e. the represented knowledge is usually dynamic and complex – possibly exactly because otherwise the use of such a difficult concept would not be justified. In other words, the conceptual difficulty might be viewed as prerequisite that allows for the representation of complicated content. In sum, facing these impediments, the lack of common sense on simulations appears to be understandable.
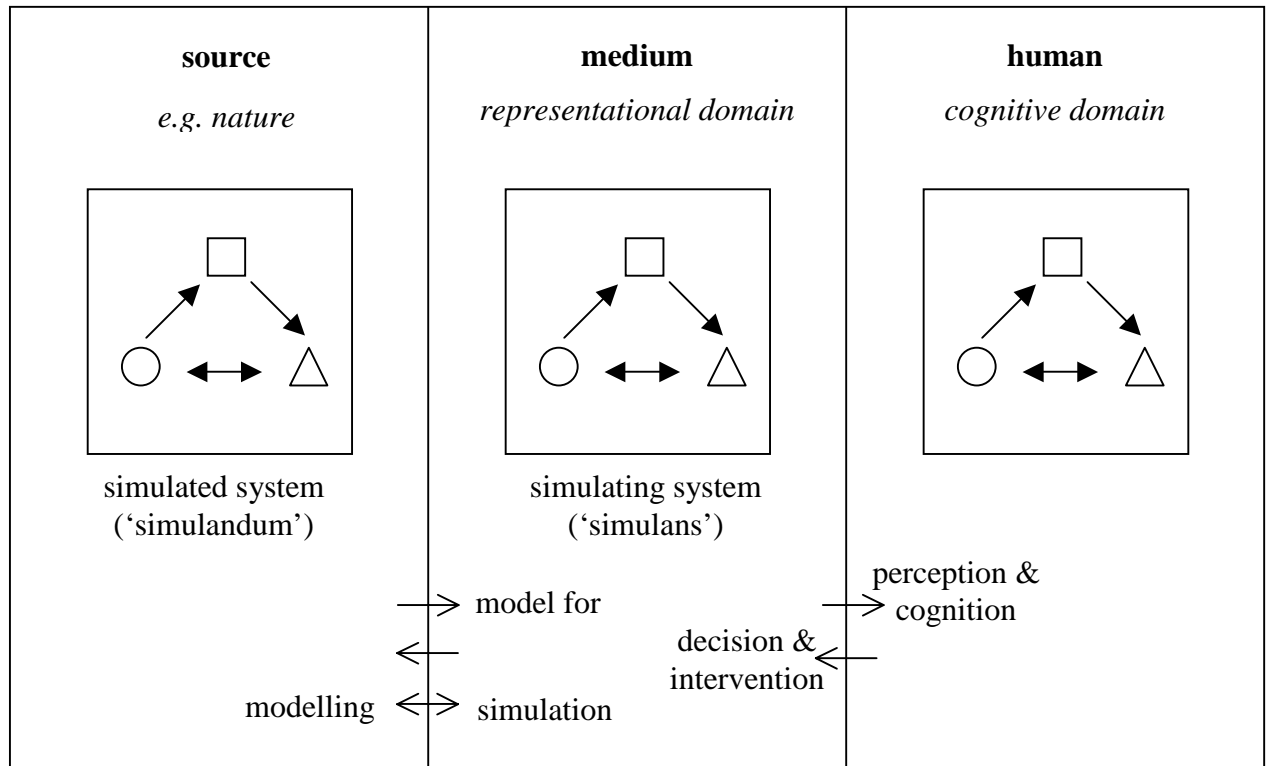
Fig. 1: The concept of simulation. Simulations refer to a certain system (box with symbols). The system shows inherent functionality which results from the activities (arrows) of the constitutive elements (symbols) according to certain regularities. At least three levels of simulation can be distinguished: The source denotes the simulated system ('simulandum'). The knowledge structure ('simulans') is located in an abstract representational domain. The relation between simulans and simulandum is that of modelling. Simulations depend on interventions and are therfore instatiated in a simulator, e.g. a cognitive system.

2 Towards the Core of Simulation

2.1 Simulations as Media

The impediments explained above raise the question where to begin with standardization attempts? Usually, standards are to be applied to media. Consequently, simulations should be conceivable as a certain type of medium that runs on a device (as a film that runs on TV). On this view, the simulation would be what is left, when the device is removed. If people were asked what device could be taken for realizing simulations, the answer would in most cases presumably be: a computer! The obvious reason is that the 'inherent functionality' (see above)

of simulations depends on an implementation that goes beyond plain rendering. In order to provide all the facilities necessary to process and control a simulation, a versatile device as a computer seems to be indispensable. But the fixed focus on the computer sometimes hinders a clear view on the essentials. Think of simulations on cell phones or, particularly, on TV accessible via digital satellite receivers and used with remote controls. Such applications might be tomorrow's standards.[i] However, simulation may even happen without any technical help, e.g. in social simulations (role plays). In these cases the device is provided by humans and the medium is spoken language (sometimes combined with print media containing definitions and rules). Finally, simulation may also happen exclusively in the cognitive domain. For example, consider an athlete (e.g. a high jumper or bob pilot) cognitively simulating the task before starting his attempt.

The case of cognitive simulation is important to attempts of standardizing simulations. It shows that simulation can very well be given without any tangible representation as a medium. The representation can be exclusively cognitive. Of course, to a certain degree this situation applies to all kinds of media: A picture, a text or a film is only a functional medium when perceived and processed in some way. But a pure cognitive representation of films and texts is not easily conceivable. (It seems easier to conceive the cognitive form of films or texts *as* cognitive simulations.) On the other hand, films or texts as pure media have a straightforward meaning (video-tape or book). Thus, films and texts are well-defined by being a specific medium.[ii] Certainly, a simulation can be represented on CD (e.g. SimCity), but a simulation on CD appears not to be as complete as a film on video-tape or text in a book.

A possible answer to the question what is actually missing could be: Simulations are generally not consumed, like films and texts are consumed, but have to be *done.* Doing a simulation requires actions and actions require decisions. Simulations are incomplete as long as nobody decides what shall happen and carries out the corresponding interventions. Consider a rehearsal of a text or imagery of a film and compare these to simulation. More specific, compare (perhaps facilitated by closed eyes) a mental film of high jumper's attempt to a cognitive simulation of the high-jumper's attempt. In the case of the film the trajectory is fixed and the result is known. In the case of a simulation the trajectory still has to be determined – according to different hypothesis certain steps can be exchanged, varied, tried anew etc. – and the result of the simulation will depend on the decisions made in the runtime

of the simulation. While the cognition that accompanies films and texts is primarily media-driven, cognition that accompanies simulations has to drive the medium.

In sum, the attempt to distinguish between media and device fails in the case of simulations because the device still has to specify what the medium will be like. On this view, simulations are characterized by a lack of specification. This raises serious questions for any standardization attempt: How can we standardize a lack of specification? How can we expect a self-contained format for simulations, when there will always be blanks in simulations that have to filled in by human decisions?[iii] On the other hand, the analysis above peeled out a *human factor*, namely decisions (and eventually interventions) carried out in runtime of simulations that distinguish simulations from other media. Thus, when standardization attempts come in at this point, there is a chance of finding telling and specific criteria for specifications.

2.2 Standardizing Humans?

Standards usually refer to media, not to human decisions. How can a standard for simulations that incorporates human decisions be accomplished? Even though there is no clear cut between medium and human, there is still a medial part and a cognitive part of the simulation. Since there is no way to standardize the human decision process itself, the place nearest to the decision process has to be chosen. This place is at the interface between medium and human. An adequate conceptual framework has to encompass the medial and human part and the respective interfaces (see also Fig. 2). Consider a user in front of a simulation-device (e.g. a computer with monitor) starting a simulation (of a thermostat, for example) with a control instrument (e.g. mouse). As stated above, the simulation shows an inherent functionality. In order to unfold that functionality the user has to act on the simulation. Interventions[iv] change the state of the simulation from $S(t_0)$ to $S(t_1)$ that might be monitored (in most cases visually) and fed back to the user. Cognitive processes referring to the new state at t_1 of the simulation close the circle. Another intervention establishes a feedback-loop. Then, the user is embedded in the simulation-cycle.
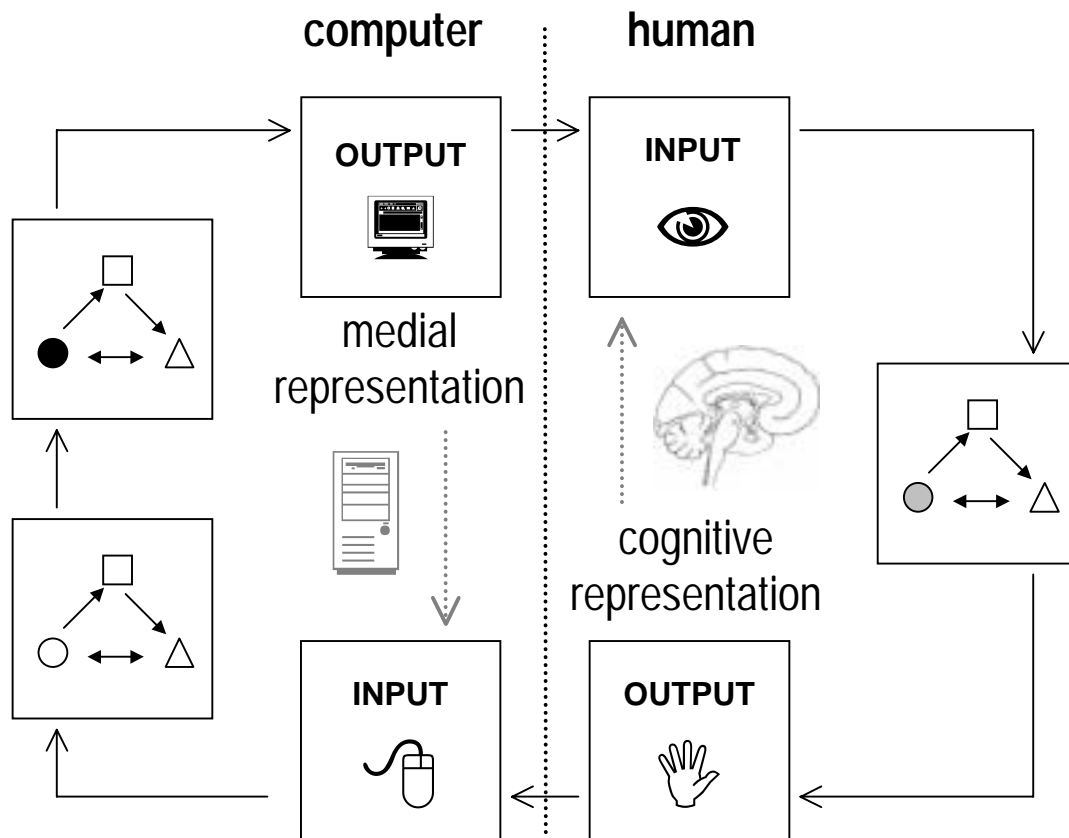
Fig. 2: Simulation cycle. The user receives sensory input of a system's medial representation, processes it and decides to start an intervention that is realized via behavioral outputs and device inputs. The intervention affects entities in the medial representation of the simulated system at a certain point in time (t_0). These changes cause changes in other elements of the system due to certain regularities. The overall result is a new state of the system (t_1) that is presented on an output device and processed again. Arrows indicate temporal order. Dotted arrows indicate that a process is carried out only virtually.

The way by which the user can inform the medial part of the simulation about the decisions is an intervention that can be transmitted through the input devices. The intervention is received at a specific interface between medium and human. Such *intervention ports* are usually realized as buttons, sliders etc. In the absence of methods that directly include the decisions, they can be constrained by providing a limited number of intervention ports, providing them at certain places, at certain moments in time etc. As prescriptions for the design of intervention ports, standards reflecting the human factor could well be introduced. Intervention ports have the neatest correspondence to human decisions in the medial representation of the simulation.

2.3 A Theory of Cognitive Simulation

Practitioners might maintain that – even without any explicit consideration of prescriptions for intervention ports and a theory about the corresponding cognitive processes – there are many examples of well designed simulations. Indeed, we have a tacit understanding of intervention design (i.e. we know where and when we have to place a button or slider).[v] But in order to state *explicitly* and explain *causally* what factor enhances or weakens the simulation we need to test systematically along the lines of a theoretical framework encompassing the corresponding cognitive processes. The analysis above showed that simulations represent complex and dynamic knowledge by providing systems with inherent functionality that are to be operated by specific interventions. According to this description, a cognitive theory must explain:

1. the representation of complexity and dynamics
2. how representations can be inherently functional
3. inferences based on these representations
4. how decisions and interventions are inferred and carried out
5. the general correspondence between medial and cognitive simulation (i.e. provide a representational framework)[vi]

Cognitive psychology offers several approaches of such complex or 'molar' knowledge structures, e.g. schemas (Bartlett, 1932; Rumelhart, 1980; Mandler, 1984), frames (Minsky, 1975), scripts (Shank & Abelson, 1977) and mental models (Johnson-Laird, 1980, 1983; Gentner & Stevens 1983). According to Brewer (1987) the former three can all be subsumed under schemas while mental models have to be distinguished from these. Brewer describes schemas as unconscious mental structures underlying the molar aspects of human knowledge and skill that involve 'old' generic information. Mental models, then, shall account not only for 'old' information but also for situations we have never been in before, i.e. imagery and inference. Concerning the differences, Brewer points out that schemas are precompiled generic knowledge structures while mental models are constructed at the time of use. Thus, with respect to the demands 3 and 4, mental models clearly outperform schemas as a candidate for explaining simulations. (Even though schemas might not be right choice for explaining inference, they definitely play a role in explaining the 'precompiled' parts of a mental model.)

Inside the research tradition of mental models two different threads have to be distinguished: one referring primarily to Johnson-Laird (1980, 1983) and one referring primarily to Gentner and Stevens (1983). According to a distinction that Markman & Genter (2000) suggest, each approach might play its specific role in explaining simulations – Johnson-Laird's in the explanation of *logical* models, while Gentner & Stevens' in the explanation of *causal* models.

Obviously, there are many more sources to be taken into account for explanations of the cognitive aspects of simulation. For example the issues of implicit learning (Berry & Broadbent, 1988), procedural knowledge (Anderson, 1993), complex problem solving (Dörner & Wearing; 1995; Funke, 1992) or general cognitive architectures (Anderson, 1993; Laird, Newell & Rosenbloom, 1987) certainly provide rich resources. Most notably, there are accounts directly addressing the issue of cognitive (mental) simulation (e.g. Barsalou, 1999). But, a comprehensive review of these theories and an evaluation in terms of the aptitude for explaining simulations would be beyond the scope of the present text. In a first step, it is sufficient to put to the record that mental models provide a theoretical framework that can principally meet the demands of a cognitive theory of simulation and that numerous further specific theories can supplement the mental model theory.

3 Practical Implications

In the absence of widespread standards, each project that deals with simulations can contribute significantly to standardization ventures in that it stringently integrates specific features of simulation into their architectures (databases, metadata-tools, experimental setups etc.) and test their practical value. An example how this can be accomplished is given in the following.

3.1 Intervention Features

The *intervention type* might be passive (start/stop of a sequence), scalar (slow motion, spatial resolution etc.), discrete (setting of initial-conditions/discontinuous parameter variation), continuous (effects of parameter variation visible without further operation) or immersive

(parameter variation directly changes system representation). The *intervention depth* describes how the simulated system is affected. Ranging from external to internal the system can be affected by way of trigger, visualisation, parameter variation, element design, system variation, or system design. Intervention type and intervention depth are just two examples of simulation features that refer to the human factor.

Table 1: Examples of criteria characterizing simulations. See text for detailed description.

feature	attribute	Comment
INTERVENTION FEATURES		
intervention type	[passive	scalar	discrete	continuous	immersive	…]	ranging from minimal to maximal
intervention depth	[trigger	visualisation	parameter variation	element design	system variation	system design	…]	ranging from superficial or deep
intervention ports	[0	1-5	6-20	21-50	> 51]	number, classification arbitrary
…	…	…

feature	attribute	Comment
SYSTEM FEATURES		
system representation	[text	symbolic	graphic	…]	comprising sheer naming (e.g. filename), full-text description, formula, schemes, 3D-models etc.
system behaviour	[digits	data visualisations	animated graphics	…]	e.g. digits in a command line, plots, oscilloscopes, dynamic 3D
update procedure	[static	stepwise static	stepwise dynamic	continuous dynamic	…]	describes what changes caused by interventions are computed and shown
variables	[1 to 5 (S)	6-20 (M)	21-50 (L)	> 51 (XL)]	number, classification arbitrary
connectivity level	[> 1	~1	< 1]	quotient of variables and connections
connectivity type	[directional	mutual]	naming of predominant type
feedback	[0	1	n]	order of feedback, n is given by the number of interconnected feedback systems
learning	[yes	no]	system stores previous states
…	…	…

feature	attribute	Comment
COMBINED FEATURES		
coverage	[0 < x < 1]	quotient of variables and intervention Ports
size (time of use)	[0 < x < n]	quotient of variables x connectivity level x … related to intervention ports
…	…	…

3.2 System Features

Independent from the human factor, but indispensable for assessing and classifying the simulation are the system features. A minimalist form of a system representation would be the sheer naming of the simulandum. Other forms are e.g. full-text, formula or graphics. Dynamics and therewith the *system's behaviour* is mediated by process representations can encompass digits in a command line representing the state of (an element), data visualisations (e.g. plots or colour-coded schemes) or animated graphics resembling real-world situations. These process representations can be further characterized by the *update procedure* which can be: static (the behaviour is visualized as a simple plot, e.g. representing an input output relation, no intervention possible), stepwise static (interactive plotting of states, one datum per intervention), stepwise dynamic (triggering one sequence after initialisation, e.g. a 'sweep' shown in an oscilloscope) or continuous dynamic (effects of interventions are visualized dynamically in runtime). Complexity can be characterized by the number of variables contributing to the functionality and the connectivity between them. For pragmatic reasons the *number of variables* could be classified: 1 to 5 (S), 6-20 (M), 21-50 (L), > 51 (XL). Several cases of *connectivity levels* could be taken into account (approx. mean values): each variable affects each other variable (>1), one variable affects one (~1) or less than one (<1) other variable. It might be practical to distinguish *connectivity types* on the basis of specific architectures (hierarchical, serial, parallel, layered etc.). In the spatial domain, connectivity can be predominantly directional or mutual. In the temporal domain connectivity can be 'feed-forward' or 'feed-back'. If specific rules change the connectivity as such (and the changes are stored) *learning* takes place in the simulation. Functionality could further be described by the type of operators used: It can be qualitative, namely logical (and, or,...) or relational (more, less...), or quantitative in terms of numerics. However, this concrete specification should be left to formal experts.

3.3 Combined Features

The above named criteria describing intervention and system features can be combined to form further telling criteria. For example, an important feature is that not all of the variables of the simulation are accessible to the user. In most cases – especially in the educational domain – the challenge of intervention design is to provide only 'relevant' intervention ports

to specific variables while the 'irrelevant' variables are covered. This *coverage* can be defined as the ratio between the number of intervention ports and the number of contributing variables $(0 > x > 1)$.[vii] In a similar combinatorial fashion, the size of a simulation can be defined as the state space of the system, e.g. by merging the number of variables with depth and type of spatial and temporal connectivity and relate this to the number of intervention ports. Such a feature (also to be properly designed by formal experts) could gain insight on the time-range a simulation offers: Greater state spaces generally contain more possible trajectories a user can choose and the greater the number of trajectories the greater the time a user can spend.

3.4 Things Left Aside

Beside the intervention and system features that characterize simulations as media, simulations have a specific content, belong to a subject etc. Numerous criteria for describing the simulated system in this respect can be found, e.g. is it concrete or abstract, natural or artificial etc. However, those features are not under investigation here. It is assumed that every application will have its own taxonomy for the respective subject area, probably borrowed from bibliographic databases. Also ignored were the technical specification criteria: Which programming language is used (e.g. C/C++, Java, Delphi), is it a pre-specified format (e.g. Toolbook, Shockwave), which platforms (Win, MacOS, Unix-derivatives, cross-platform etc.) are possible etc.? Furthermore, the simulation may have a specific role, e.g. scientific, educational, economical etc. For characterizing simulations as educational media, for example, it has to be specified which type of use (e.g. demonstration, individual, grouped) is possible, which prerequisites (previous knowledge, qualifications etc.) are given, what the context is (single unit, course, exam) etc. Here the LOM or such projects like the Educational Modelling Language EML (http://eml.ou.nl) come into play, since they provide metadata designed for this purpose. A comprehensive characterization of simulations as media somehow has to incorporate all types of criteria. Of course, it should ensured that the resulting set of criteria is small enough to be manageable.

4 Summary and Conclusion

The analysis given above can be summarized as follows: (1) Simulations have specific features: They represent inherent functionality of a (complex and/or dynamic) system that is

to be operated by specific interventions. (2) The core of simulation is cognitive: Simulations contain a human factor (i.e. decisions preceding interventions) that cannot be directly included in simulation standards, but can be approached indirectly by the design of intervention ports. (3) Standardization ventures should therefore refer to a (still not mature) cognitive theory of simulation (and corresponding experimental paradigms) that should protect them from ending half-way because having missed the (human) point.

In sum, the venture of standardizing simulations is still in his infancy. The period of every expert clearing his own path to simulation is not yet overcome. With respect to conceptual difficulty, semantic variety and the specialization in complicated content, the must of expertise is no surprise: The versatility of simulation takes a heavy toll on standardization! However, continuing effort will make this exclusive medium – at the moment primarily preserved to experts – finally fully accessible to the public. The venture of standardizing simulations goes uphill all the way – but it goes.

Bibliography

Anderson, J. (1993). *Rules of the Mind.* Hillsdale, NJ: Erlbaum.

Barsalou, L.W. (1999). Perceptual symbol systems. *Behavioral and Brain Sciences*, *22, 577–609.*

Berry, D.C. & Broadbent, D. E. (1988): Interactive tasks and the implicit/explicit distinction. *British Journal of Psychology, 79* (2), 251–272.

Bartlett, F.C. (1932). *Remembering: An Experimental and Social Study.* Cambridge: Cambridge University Press.

Brewer, W. (1987). Schemas versus mental models in human reasoning. In P. Morris (Ed.) *Modelling Cognition* (pp. 187–197). New York: John Wiley.

Crookall, David (2001). State of the art and science of simulation/gaming. *Simulation & Gaming, 32* (4), 449–450.

Dörner, D. & Wearing, A. (1995). Complex problem solving: Toward a (computer-simulated) theory. In P.A. Frensch & J. Funke (Eds.), *Complex problem solving: The European Perspective* (pp. 65–99). Hillsdale, NJ: Lawrence Erlbaum Associates.

Fishwick, P.A. (1995). A Taxonomy for Simulation Modelling Based on Programming Language Principles. *IEEE-Transactions on IE Research*, *30,* 811–820.

Funke, J. (1992). *Wissen über dynamische Systeme: Erwerb, Repräsentation und Anwendung.* Heidelberg: Springer.

Gentner, D. & Stevens, A. (1983). *Mental Models.* Hillsdale, NJ: Erlbaum.

Gordon, R.(1986). Folk Psychology as Simulation. *Mind and Language, 1,* 158–171.

Heitzmann, W.R. (1973). The validity of social science simulations: a review of research findings. *Education, 94* (2), 170–175.

Johnson-Laird, P. N. (1980). Mental models in cognitive science. *Cognitive Science, 4*, 72–115.

Johnson-Laird, P. N. (1983). *Mental Models: Towards a Cognitive Science of Language, Inference, and Consciousness.* Cambridge: Cambridge University Press.

Kieras, D.E., & Bovair, S. (1984). The role of a mental model in learning to operate a device. *Cognitive Science, 8,* 255–273.

Laird, J. E., Newell, A. & Rosenbloom, P. S. (1987). Soar: An architecture for general intelligence. *Artificial Intelligence, 33,* 1–64.

Mandler, J. (1984). *Stories, Scripts, and Scenes: Aspects of Schema Theory.* Hillsdale, NJ: Erlbaum.

Markman A.B. & Gentner D. (2001). Thinking. *Annual Review of Psychology, 52,* 223–247.

Minsky M. (1975). A framework for representing knowledge. In P. Winston (Ed.) *The Psychology of Computer Vision* (pp. 211–277). New York: McGraw-Hill.

Rumelhart, D.E. (1980). Schemata: The building blocks of cognition. In R.J. Spiro, B. Bruce, & W.F. Brewer (Eds.), *Theoretical Issues in Reading and Comprehension* (pp. 33–58). Hillsdale, NJ: Erlbaum.

Schank R. & Abelson R. (1977). *Scripts, Plans, Goals and Understanding.* Hillsdale, NJ: Erlbaum.

Schmucker, K. Apple Computer Inc., (1999). A Taxonomy of Simulation Software, *Learning Technology Review*, Fall 1999/Spring 2000.

Cited Internet addresses

EML: http://eml.ou.nl/
IEEE-LOM. http://ltsc.ieee.org
MONIST-Project. http://www.monist.de
MPEG Working Group. http://www.mpeg.telecomitalialab.com

Notes

---

i It should be noted that the MPEG-Consortium (http://www.mpeg.telecomitalialab.com) has acknowledged this challenge in their specification process of the forthcoming MPEG-formats 7 and 21 that attach more importance to interactivity.

ii In simulations, the functioning of the medium as such is modified. Such decision processes are not possible in films or texts. Changing the functioning of films or texts would mean to

intervene in the plot, e.g. by changing the character of a role. Of course, a DVD offering different ends for films or texts offering several strands of the plot might be conceived as marginal cases. However, they are not distinctive features of the respective medium.

[iii] Maybe, it is the difficulty of this task that hindered the most an emergence of a unified conception of simulation as media. Providing space for decision processes means to provide certain degrees of freedom – and providing degrees of freedom is something that directly contradicts the nature of standardisation. It is hardly conceivable that this field of tension is easily overcome.

[iv] Since the term 'interaction' gives rise to uncertainties about the causal direction of a relation and, particularly, since it does not clearly express that a simulation is driven by the user's decisions (e.g. by parameter variation) the term 'intervention' is used.

[v] The design of simulations might be so familiar to us because cognitive simulation is a natural way to compile knowledge (cf. Barsalou, 1999). Moreover, the designer's (author's) method to anticipate what the user will do is conceivable as a mental simulation as it is used to explain folk psychology (cf. Gordon, 1986).

[vi] Actually, this demands do not differ substantially from the demands for any general theory of cognition. But this is not at all surprising since – with their capability to represent dynamic and complex knowledge structures – simulations are the highest benchmark for cognition and, therefore, have to encompass most other forms of cognition.

[vii] The art of designing a simulation as a convenient medium is to make the necessary decision processes easy, to design easy intervention ports. It should be noted that – contrary to the widespread expectation of 'good' simulations being massively interactive – interaction might be heavily restricted in convenient simulations. In this sense, a simulation that shall be powerful, is at risk of being inconvenient. On the other hand, a simulation being user friendly is endangered of being trivial. Thus, simulation design is always a power-convenience trade-off.