Virtual Reality - Real Virtuality

On the Interaction between Simulation and Reality

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ABSTRACT

A central feature of social entities is that they are model-builders. This model-building is intentional in the sense that it guides actions in the real world. Since models are intentional, they have to reflect processes in reality, depicting what the entity considers to be essential. In other words, a *virtual reality* is created. If it comes to computer simulation of this model-building behaviour, this implies that the mental models, i.e. virtual realities, are translated into a simulation language. In doing so models of models emerge. Evidently the latter process might involve another social entity with its own way of model-building.

Since this simulated world is a virtual world that nevertheless is induced by real processes and indeed is embedded in them, we could speak of *real virtuality*.

The paper will analyse these multifaceted relations and will outline the various ways in which "knowledge" can be generated.

1. Introduction: Social Entities as Model-Builders

Virtuality has become a popular heading with respect to computer simulations. Since in several fields - such as computer games, medicine, planning, design etc. simulations are used to support activities, offer training opportunities, and the like, the notion of virtuality is used rather inflationary. In order to go beneath the surface of common understanding of virtuality the paper will return to the essential aspects of creating virtual worlds, namely as a way of transforming perceived information into mental models.

From the very beginning of human societies the Homo sapiens lived in groups. The individuals in these groups have to co-ordinate their activities and they do so by the use of a language. As Chomsky (1970) pointed out language determines thoughts. Thus if a group shares a language it has also to share thoughts. In order to co-ordinate and adjust activities the group members must apply a common mental model of their environment.

There is a long philosophical tradition in discussing meaning and mind. As Putnam (1988) points out: *"to mean something was probably, in the oldest usage, just to have something in*

mind. Be this as it may, the picture is that there is something in mind that picks out the objects in the environment that we talk about. When such something (call it a "concept") is associated with a sign, it becomes the meaning of the sign."
The notion concept refers in his terms to "representation in minds" implying that every word an individual uses is associated in the mind of the speaker with a certain mental representation which - vice versa - determines what the word refers to, if anything.

This means that the mental model of each individual usually will differ somewhat from the others,- a statement which will be discussed in more detail in the chapter 2.
A vital element in learning - in terms of (re-)structuring real world perceptions - is the fact that human beings tend to "theorise" their experiences (see also Althusser 1968). As a consequence models are results of theorising, which are coupled by feedback loops with their real world. By using these models for acting social entities are intentional[1] (for an interesting discussion see Putnam 1988).
Bourdieu (1983) points out - that from a scientific perspective - the most relevant issue in social systems is the structure of relations between the entities. As a consequence he insists on the fact that there exists a "bigger" reality of objective relations than the reality of directly experienced realities individuals do have. This means that focussing on the mental models of individuals will lead to the neglect of underlying structures determining the position of these individuals. For scientific purposes Bourdieu suggests to focus not on the individual subjects but on the relations between them, since social relations are something else than the relations between individuals or the imaginations these individuals have.

Based on this essential assumption, namely that social entities are model-builders, it is pivotal to focus on the process of model-building and of modelling models. These aspects are particularly interesting with respect to computer simulation.

2. Models: Virtual Realities

The term "model" is used in several different fields of life: While some mean a human being representing the social convention of "beauty", others would associate their miniatures of ships, cars and other technical artefacts. What all these different links do have in common, is that models are representations of parts of the real world - even if they are rather abstract (such as beauty). A similar picture can be drawn when discussing the meaning of "virtuality". Obviously this term should refer to "something not real" or as the dictionary says: that is such for practical purposes though not in name or according to strict definition (the Concise Oxford Dictionary, p. 1200).

Casti (1992) suggests to distinguish between several types of models, whereby he focuses on the notion of "model" from a system science or applied mathematics point of view. In these fields - to which Cognitive Science belongs too - a model is a formal representation of the modeller's reality, an interesting issue dealt with in chapter 3. Usually a mathematical model is understood as a precise statement of relevant characteristics and assumed properties for the

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[1] 'It is important to notice that the acts and activities of using a language are typically intentional.' [Hacker, 1987, p.495].

problem under consideration. Thus the purpose of a model is either to test assumptions (by coupling the results of a simulation run with empirical data) or to draw conclusion (in terms of prognoses). The potential limits of modelling are heavily discussed (see e.g. Walker 1994) starting with the problem how to test assumptions, via the testing of programs (semantically), to the usefulness of forecasts. Bourdieu (1983) stresses the potential of formal or informal models. They substitute experiments with actual processes - which in most of the cases would be impossible anyway. A model offers the opportunity to compare consequences of different sequences of actions without risking dangerous interaction with the real world - since a model is a fictive construct. Contrary to memetic models - that merely reproduce the phenomenal attributes instead of the function of an object - analogous or structural models highlight the structure of constructed relations. This is so, because the latter are formulated based on systematic abstraction and methodological comparison.
A model thus is a virtual reality for a social entity. Social entities using these immaterial potential realities are not only human individuals. As already mentioned above, in human societies there exists a primacy of the group - models typically are models of a larger social entity, a family, an enterprise, a national bank, a nation. At closer examination, the so-called 'individual' rather is a theoretical construct of the late 19^{th} century, and not the basic element from which deduction can explain the emergence of human groups. The basic analogy that cognitive science investigates should not be that between individual brain and individual consciousness, but that between interaction in larger social entities and the models these entities use. Norbert Wiener (1948, p.156) seemed to share this view when he defined communication in societies as a substitute for 'the fixed nervous system, with permanent topographic relations' that an individual has. And it is models formulated in a common language that are communicated in these hierarchies of social entities.

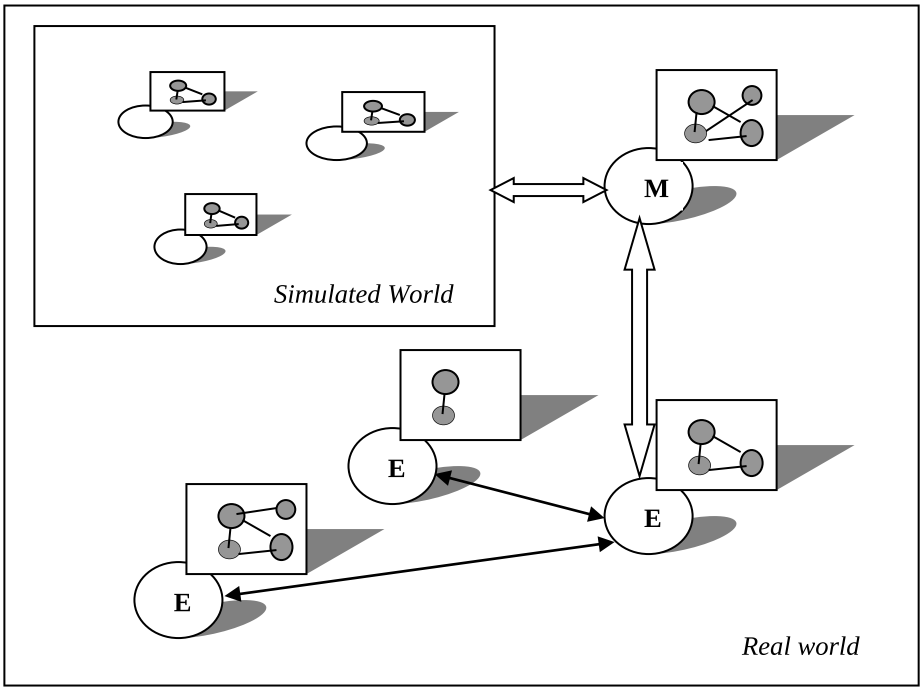
Two important properties of human model-building thus have to be emphasised:
First, the social entities that entertain them are organised in complicated, partly overlapping hierarchical structures. Exchange of models - be it learning, teaching or manipulation (compare Hanappi, pp.21-41) - is always encompassed by these structures.
Second, models of social entities are often quite complex. Though it is tempting to start with the assumption of 'simple minds' (compare Lloyd, 1989) and then to derive more complex minds, this procedure fails if there is a serious quantum leap between the two. As recent results in 'artificial life' showed, research there that started with the interaction of many homogenous entities using overly simple models produced sometimes surprising but from a social science point of view mostly uninteresting results. Contrary to that the interaction of less, heterogeneous and well-structured social entities now often proves to give deep insight in real world processes. In the latter case artificial life often steps in when the analytical powers of game theoretic approaches fail.

Virtual realities, seen in this perspective as models of social entities, are an omnipresent phenomenon. As a famous economist once put it: *'Practical men, who believe themselves to be quite exempt from any intellectual influences, are usually the slaves of some defunct economist. Madmen in authority, who hear voices in the air, are distilling their frenzy from some academic scribbler of a few years back'* (Keynes, 1936, p.383).

3. Computer Simulation: Models of Models

As already mentioned computer simulation can be characterised that one's model is described in a mathematical language. This means that a model of the model is made. The following graphical representation (figure 1) will highlight the most important aspects:

Social entities E do have mental models that might differ from each other. The modeller in our case being another social entity with his/her own way of model-building tries to catch the mental representation of a certain individual. Since each model-builder is paying his/her attention only to selected facts/phenomena, the various models will - again - be different from each other. This is also true for the implemented model - the simulation.



An essential aspect of this modelling-building process is that social entities do not have complete information, i.e. their models are a reduction of the real world (in game theory these settings are investigated as *games with incomplete information*, compare [Bierman/Fernandez, 1998, p.271 ff.]). The modeller has to rely on the (incomplete) model of the communication partner, and will - by himself/herself - highlight only those aspects seeming essential to him/her. In order to get a criterion for the quality of the implemented model, feedback loops are necessary. This can be realised by the use of adaptation mechanisms induced by empirical findings.

Let us look at this process in more detail to identify the sources of necessary and dangerous disturbances of the 'true' models entertained by the different entities.

First, the model building entities themselves (E) necessarily reduce real processes to a subset of formalised processes that they think to be essential for the purpose the model is to be used for. Clearly this reduction can be more or less adequate. If a physical process with no involvement of another social entity is concerned, then this reduction is simply the discovering of a physical law. Such laws evidently can be more or less valid for the purpose at hand, e.g. Newtonian physics for certain parameter ranges. The source of disturbance in this case could either be a wrong set of essential processes and/or variables *for this problem*, or an inadequate parameter range. Note that reduction is necessary to deduct forecasts and that therefore a certain stochastic in the validity of the model is unavoidable. Indeed these disturbances are *necessary* for testing and improvement of the model.
The situation changes dramatically if other entities using their models play an essential role in an entity's model. On the one hand other entities models have the great advantage that they can be modelled completely correct: Since they are already reductions of reality formulated in a model language, they can simply be copied into an entity's own the model. They can be 100 percent correct representations! On the other hand, even if they are true as copies of the mental representation of somebody else, they still include the errors the other entity might have made. Call the first entity E_1 and assume that it uses a model that includes actions of model-building entity E_2. To learn about the mistakes E_2 might have made, E_1 must make an assumption about the intentions that caused E_2 to formulate its model. Only in that way the reductions present in the latter can be evaluated. A widespread error made is, to assume that other entities always follow the same intentions as oneself - in economics this problem of adequate specification of intentions is known as the incentive compatibility of prescribed co-ordination mechanisms. The errors E_1 can make consequently fall into different categories:

- Though in principle possible, it might be difficult to find out the model E_2 really uses.
- The intentions that caused the model of E_2 might be assumed incorrectly.
- There is a necessary disturbance of E_2's model, see above.

In particular, the third case often includes the errors E_2 makes in anticipating other entities' behaviour.
If E_1 tries to determine the source of a bad prediction of the model, it turns out that this is not an easy task. Errors from different sources can amplify or compensate each other. But even if some forecasts with the model turn out to be reasonably correct, there is not too much reason for confidence in the model - with slowly moving variables and sufficiently slow adjustment equations whole classes of wrong models can produce seemingly good results.
To correct a model with bad predictive properties therefore often follows simple heuristic rules - more sophisticated ones simply are not worth the effort given the little information they can be based upon. The most primitive one clearly is the one to stick to the existing model until repeatedly really bad forecasting errors occur. And if this happens, the model is abandoned completely - and replaced by another oversimplified model that is superior in ex-post forecasting of the latest events. Note that this procedure is perfectly in line with Howard Gardner's view of the cognitive science of social processes:
'But as one moves to more complex and belief-tainted processes such as classification of ontological domains or judgements concerning rival courses of action, the computational model becomes less adequate. Human beings apparently do not approach these tasks in a

manner that can be characterised as logical or rational or that entail step-by-step symbolic processing. Rather, they employ heuristics, strategies, biases, images, and other vague and approximate approaches.' [Gardner H., 1985, p.385]

Finally let us introduce a professional model-builder M, who supports entity E_1 with a computer simulation of the situation. In a sense M is just another entity E with some special features derived solely from its capacity to construct simulation models. The following steps of M's simulation support can be distinguished:

1. Extract the model E_1 uses, including the models E_1 assigns to other entities in his model.
2. Translate it into a common, consistent formal model.
3. Transform it into an algorithmic model.
4. Run the simulation.
5. Interpret the results.
6. Reduce the results to a set that is thought to be interesting for E_1.
7. Communicate this subset to E_1.

Everything that has been said for the model building of E_1 clearly applies for M too. But now there is even more to say. Step 1, extraction of other peoples models often implies that these models loose their implicit, some like to call it 'tacit', character. Forcing entities to make their model explicit sometimes transforms it. In particular, if in step 2 the explicit model is checked for consistency, it might well be that inconsistent parts are modified. That does not necessarily mean that one of two contradictory relationships (equations) has to be dropped. But it will force the specification of a sensitivity border that determines which of the two relationships is valid on which side of the border. Note further that the emphasis on a *common* model is not rhetoric. Only in a common model overall consistency can be checked and only with a common model all superfluous parts can be eliminated. Step 3 is crucial in that it makes clear that the language of algorithms has to be distinguished from natural languages *and from mathematics*. A detailed treatment of the latter difference goes beyond the scope of this paper, but what has to be mentioned is that the early days of programming - when algorithmic languages were simply imitating the language of mathematics - are definitively gone. Nowadays it often is the other way round, algorithmic elements invade mathematics (e.g. compare Gregory Chaitin (1997)). As is the case with any translation, the structure of the new language permeates the model. In fact steps 5 to 7 have to be considered as an iterative process - the core activity of entity M. Preparing the usually large amount of multi-facetted simulation results for communication with E_1 (step 8) in a sense is a translation back in the original language. Final communication in step 9 closes the first round of support - and at the same time initiates the 'empirical' feedback loop of entity M.
This feedback loop hints at another special property, the intention of the model constructed by entity M. It should be clear that M will be compensated for its modelling support by some (financial) transfer from entity E_1. Success, positive stimulus, thus coincides for M with a model that fits the purposes and tastes of entity E_1. In other words there is some implicit transfer of intention from E_1 to M. The gap between a truthful model (in the eyes of M) and a model that convenes E_1 evidently can be rather wide.
Virtual realities - models - *involving interaction between social entities* thus happen to consist of different layers formulated in different languages and underpinned by partly conflicting

intentional structures. And this makes them radically different from virtual reality examples that model only the material (physical, chemical, optical etc.) properties of 'machinery' - e.g. a flight simulator.

4. Real Virtuality: The Potential of Simulation Models

Social entities live with their models. For satisfied basic needs one can observe that the more complicated their environment the less they are inclined to change their models very often. Above all social entities are themselves physical entities too, parts of real processes. One could safely claim that their relatively stable models are the most conservative - in the sense of conserving, memorising - part of their physical dynamics.
In the setting introduced in the last part of the last chapter it turns out that it is often very hard to falsify a model - not to talk about its validity. In particular, as could easily be shown with some game theoretic examples, there can be an infinite set of possible information and model assumptions (remember that they are based on assumed intentional structures) that all fit perfectly to a given finite set of observed data. But this does *not* mean that model-building is arbitrary[2] - at any point in time there definitely is a set of models that is actually used by a set of entities E, and a model-builder M can get more or less close to this set. Quite to the contrary, the power of simulation consists in its property to make explicit, to provide concrete results, even to provide *concrete metaphors* that in the moment are not realised.
Add the specification of possible structures of possible social entities, a point expounded in chapter 2, and the necessity and power of simulation support becomes even more evident.

The volatility that might be introduced by more sophisticated modelling support therefore could be seen as a welcome potential for the possible design of new, perhaps radically changed social interaction patterns. It is precisely the indeterminacy implicit in the layers of languages and reduction procedures that enables a range of choice between possible alternatives in the real world- *real virtuality*.

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[2] This is the basic flaw in Paul Feyerabend's approach of 'Anything goes'.

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