Reality Determination through Action

Matthias RAUTERBERG
Designed Intelligence Group, Department of Industrial Design
Eindhoven University of Technology (TU/e), Eindhoven, the Netherlands
g.w.m.rauterberg@tue.nl

***Abstract* - The question about the nature of real worlds (true reality) and virtual worlds (artificial reality) is not as easy to answer as it appears at first glance. How do we perceive real or virtual worlds? How can we differentiate between real and virtual worlds? In order to understand what real and virtual worlds are and what their definite distinctions are at best, it is necessary to first outline the fundamental aspects of perception and knowledge, as well as assume the various epistemological positions. Since the meaning of the world is primarily established by actions, the individual knowledge of the world is stored in an action-related manner. Instead of a passive portrayal, the world is determined actively. Understanding is only possible in the re-construction of the world. Re-constructions that can be inter-subjectively experienced with the senses in an objectivised or inter-subjectively imparted form enable new dimensions of communication. Modern technology can contribute to this cultural development.**

***Keywords* – action; culture; reality; virtual world**

I. Introduction

For any cultural relevant technology it is still an open question, how to design such kind of technology to make it utmost meaningful to their users. In this paper we describe the basic principles by discussing the difference and communalities between real and virtual worlds. Actions are the foundational base for understanding the world, and in this respect we go beyond Dourish [1]. The need for a deeper understanding how action determine our reality is clearly expressed in [2].

A. Percipience and Cognition

There is a fundamental and still largely unsolved problem in the recognition and naming of unknown patterns in the totality of perception. The perception of meaningful units in the visual world apparently depends on complex operations that are not consciously accessible and can only be proven indirectly [3]. This may be based on the problem of universals, which is still unsolved. Do universals (in the sense of *objective concepts*) even have an independent existence outside of the mind of a cognitive and perceiving subject? If there even is such a thing as *universals* – they do not exist as static entities (e.g. *concepts*) but as dynamic processes (e.g. *actions*). The following positions are taken on universals:

(1.) *Nominalism* (represented by Ockham) clearly answers the question of universals with yes. According to this position, universals are names for individuals and there are only individuals who exist in the objective reality.

(2.) *Positivism* can be divided into two different views. One of these two views can be summarised as *transcendental realism* (also frequently called *idealism* and represented by Plato). The Platonic *idea* exists eternally as an objective concept beyond and independent of a cognitive mind. This view is also called *extreme realism*. The other view is *immanent* or *moderate realism*. Here Aristotle differentiated two principles: (I) *matter*, which for all intents and purposes provides the raw material of the individuating, independent and universal principle; (II) *form* is the understandable and cognizable entity of reality (see also [4]). Although the form may be universal, it is dependent on the existence of a cognitive mind.

(3.) The third position is *conceptualism*. There are no universals for conceptualism since the concepts are defined through their meaning and solely occur as an association in the mind of a cognitive system. This association solely has psychological relevance, but no type of transcendentally validity.

If we apply the position of immanent realism including constructive portions to the meaning problem of *extension*, the following two meanings for *extension* can be stated: (M1) All phenomena have an endless amount of precisely determinable (i.e. specifiable) characteristics on their own; these many finite characteristics in their totality constitute the respective phenomena; only these characteristics need to be discovered and the extension is established once and for all. (M2) The phenomena have an infinite number of characteristics (i.e. dimensions according to which they can be *differentiated* from other phenomena or circumstances). From this infinitely great diversity, the respective language community [5] or culture [6] selects the differentiation dimensions that are phylogenetically inherent on the one hand [7], in addition to what has been acquired in the social reproduction process (see [8, p. 58]) on the other hand.

According to the first position (M1), *no* change of the extension can be achieved through the change of the intension. According to the second position (M2), there are no things in themselves, but just an infinitely great diversity. Consequently, a change of intension would also bring a change of extension with it; but this would occur without changing the infinitely great diversity in any way. Since the process is central to this last position, it is necessary to explain this *definition* or better *determination process* in depth.

B. Acting and Determining

From the abundance of differentiation possibilities that are made available by reality, those differences that are considered to be necessary for the constitution are defined by the *determination process*. The determination process is to be understood as a comprehensive category of any cognitive systems' actions. According to Neisser [9], the relationship between percipience and taking action is an irreversible, cyclical process: the exploration of perception as an action selects the relevant aspects from the quantity of all potentially available differentiation criteria, which in turn change the individual knowledge structure of existing interpretation schemata and invariants. Piaget [10] already had a similar view with the two processes of *assimilation* and *accommodation*. Actions serve the exploration or the

978-1-5386-1135-7/17 $31.00 © 2017 IEEE
DOI 10.1109/Culture.and.Computing.2017.16

determination and, therefore actions serve also the reconstruction of reality. In this sense, actions can be understood as determination processes that range from the use of simple, concrete measuring instruments (such as a thermometer, watch, revolution counter, etc.) to the application of complex, abstract theories (i.e. capitalism, theory of relativity, etc.) and practices (i.e. cultural computing [11], administration of justice, etc.). Each cognitive system has as its source of understanding an abundance of determination processes available to it. The simplest determination process is a binary switch (on/off, 1/0, true/false, etc.). Examples of very complex determination processes developed by humans are: culture, jurisdiction, computer, etc. In addition, determination processes can define cognitive-relevant differentiation dimensions, also in the form of opinions, cognitive attitudes and up to philosophical ideologies. Determination processes can be extremely complex and in turn also contain other determination processes [12].

The consciousness of the cognitive systems is cultivated in dependence upon the type and variety of the available determination process in a particular culture. Two cognitive systems with completely different determination processes then exist in two totally different cultures. Similar determination processes enable the same relationship with reality. There is a series of phylogenetically acquired determination processes for humans: the sensory organs, the central nervous system and the innate behaviour patterns [13]. The benefit of these phylogenetically acquired determination processes is that they optimally allow cognitive systems quick and adequate courses of action due to their direct practicability, fit for purpose, resp. With these phylogenetically acquired determination processes, the human is also integrated into the evolutionary knowledge structure of humanity, often called culture [14]. Different integrations apply for other systems in this world. In order for any cognitive system to behave as a macroscopic Gestalt in this world, it must be able to perceive the material, macroscopic structure of his surroundings, habitat, resp. [15]. For educated adults, a major portion of their knowledge - and therefore their action structure – is additionally composed of a multitude of complex determination processes that enable them to participate in natural and social life. Within this abundance, humans construct the *reality* according to the learned determination processes through structural couplings by *autopoiesis* [16] [17].

The difference between the complexity outlined by the cognitive determination processes and the complexity provided through the sensory organs forms the basis for information [18]. In order to now maintain a certain magnitude of information, a human must continuously *take action*. In this sense, action is seen in the use and updating of the determination processes. For example, if we want to know whether a thing in itself is *hard* or *soft*, we must realise the determination process of *touching* and *feeling*. Education and socialisation is the process of conveying the socially and culturally relevant determination processes. "In every new action, the acts of discovery and change are inseparably connected with each other" [19, p. 135]. Human actions are not primarily subjected to the consideration of rationality, but are embedded or stored in the cultural-historic knowledge structures and traditions of thought. The knowledge produced and handed down in a culture is more than this: It contains the sum of all cultural determination processes in the construction of the world's reality, which appears to be the only possible and correct one to each individual of this culture [20, 21].

Piaget [22] made it empirically plausible that a developing cognitive system (i.e. children) "neither passively assumes his knowledge and his understanding of reality, nor possesses it a priori, but acquires it from *the inside out*. Instead, he actively builds his reality in a construing manner" [23, p. 350]. If we apply this perspective to human behaviour as *action*, Lenk [24, p. 345] concluded: "Actions are interpretation constructs. Acting can be understood as situation-, context- and institution-dependent, rule-based, standard-, value- or goal-oriented, systemically embedded, at least partially sequence-controlled or partially consciously motivated behaviour of a personal or collective protagonist to whom these are ascribed as performed." Actions become a constituent of culture.

II. True and Artificial Reality

If we attempt to give a definition of the real world, we notice that it is very difficult to develop a strong definition for the *true world* that is non-cyclical [25]. Is the real world what is *really* around us? And what does *really* mean in this context? Isn't the true world what has not been simulated? Does the artificial flower on the table still belong to the true world? After all, it is a simulated flower [26]. Nowadays we call this cyber-physical systems [27].

A. The True Reality (Real Worlds)

What belongs to the real world and what does not is usually intuitively clear. The seat in the cinema belongs to the real world, as does the screen; but the film that is projected onto it does not belong to the real world. Does something only belong to the real world when it can be touched? This can hardly be the case because input-output devices for computers with force feedback and touch simulation have recently been offered so that the illusion of a *touchable* object is created. There are things that cannot be explicitly classified with the real or a virtual world. The decisive factor for this is the perspective, e.g. the application-oriented controlled determination process. If we consider the sets that are used to make films in Hollywood to be backdrops of plywood and cardboard, they belong to the real world. On the other hand, if they are considered to be actual houses, they belong to a virtual world. By the same token, the toy car belongs to the real world as a model, but to the virtual world of the child as a *car*. So the property of whether an object belongs to the real world or to a virtual world is also not inherent to the object but is dependent upon its intended purpose within the respective action context.

Let us imagine that we have already made a great deal of progress in the simulation of reality [28]. We could build any type of world and *populate* this world with beings according to our own taste. We would have a type of basic element such as a voxel ('voluminous pixel' see [29, p. 5]). With these basic elements, we would probably build our-

selves a finite, quantized world. The beings that we create would be intelligent so that they demonstrate an interesting behaviour. After a while, the beings would perhaps even attempt to build their own virtual realities. Perhaps we would also incorporate some type of *camouflage tactics* so that our beings would not be able to precisely measure, e.g. determine their world.

We should note that it may not be meaningful to speak about *the real world*. Instead, aren't there various real worlds in our imagination? For example, people also talk about the *world of employment* or the *world of securities trading*. If we come home after work and then go to football practice, we are moving from the world of employment through the private world to the world of the football clubs. All three of these worlds are culturally different and so we also behave differently in each of these worlds. These different worlds frequently have just a few connections with each other that are cognisable to us. It is simultaneously confusing and surprising, for example, to meet people known from one world who appear in a different world. This division of the *real world* into smaller, context-dependent worlds is very useful in the simulation.

B. The Artificial Reality (Virtual Worlds)

Virtual worlds have not just existed since the invention of the computer. The computer is only a new (but rather powerful) aid for the production of artificial realities [30]. However, such an expensive and highly developed aid is not really necessary. The most fundamental form of artificial reality is *play*. Anyone who has ever watched children or sometimes even adults while playing has observed that they can be involved with complete concentration and hardly notice anything else beyond the play [31]. People say that they "seem to be in another world". Playing basically requires few or even no aids [32].

A child can poke around in the air with a stick, but is involved in the decisive phase of a battle of life and death in his or her virtual world. A stick or a doll may be completely adequate for building a completely virtual world in the imagination of the child. However, there are also more complicated tools for the construction of artificial realities. Even a book can build a virtual world. With the help of the narrative, an entirely new world of its own is constructed in the imagination space of the reader. The next step is the visual media, beginning with painting. Pictures are usually quite static, which is why they are not especially well-suited for artificial realities. The logical continuation of pictures is film and television. In the cinema or in front of the television, we can become totally concentrated and "absent" due to creating an illusionary reality. The greatest shortcoming in film and television on the path to the simulation of reality is the lack of interactivity [33]. There is no point in attempting to intervene in the action because the film continues to run undeterred. This shortcoming does not apply to computer games. Some graphic computer games are already quite advanced in the simulation of reality. Nevertheless, they still lack certain features. The most important factor is probably the inappropriate interface design (i.e., input of commands via keyboard, mouse or joystick). The common input devices do not provide any type of meaningful action related feedback. There is no sense of touching the objects manipulated in the virtual world. Flight and driving simulators are the next step towards mixed realities [34].

Dreams are a very different type of virtual world. Since reality is practically completely switched off during sleep, the imagination is not bothered by any disruptive sensory impressions or natural constrains (e.g. gravity). It can freely develop and create realities that would not be possible to produce in any other way. Most dreams are very ordinary and cannot be remembered once we wake up. The *crazy* dreams that we can remember tend to be quite rare. Drugs are an aid that contributes to the creation of virtual worlds on a completely different level. Humans take drugs because they want to escape reality and because they feel better in the virtual world. Krueger [35] even considers systems like air conditioning to be the producers of virtual worlds. Above all, he emphasises the *responsiveness* in this regard. Air conditioning has sensors that measure the temperatures and other parameters, correspondingly adapts and therefore maintains an artificially controlled climate. Interactive computer systems with three-dimensional stereoscopic outputs and inputs of gestures are developed with the help of data gloves and head mounted displays (HMD). There are also systems with force feedback and touch simulation of objects in a virtual world [36]. All of these systems attempt to replicate a partial area of reality as precisely as possible with the help of a computer but are still insufficient when it comes to action [37].

C. Real and Virtual Worlds

We have seen that it is not trivial to differentiate real from virtual worlds. Perhaps we completely live in a virtual world that a higher being has created for its amusement or research purposes [25]. Even though it is very difficult for us to give an adequate and complete definition of *real world* as we understand it, we normally do not have a problem with deciding to which world an impression belongs. However, this is primarily because our virtual worlds are still too different from reality, e.g. cannot be experienced with *all* senses. We can usually very easily determine through some characteristic that a world is not actually real, but just simulated. We can still see the edges of a screen and the heads of the people in the front rows when we are in a cinema.

The technical development is now moving in the direction of overcoming these limitations. The differentiation between real and virtual world is becoming increasingly blurred [34]. If we want to decide whether the result of a (sensory) assessment belongs to the real or the virtual world, we must depend on our senses (directly or conveyed through measuring instruments or determination processes). Above all, most of the current virtual realities are based upon visual and auditory impressions. These two senses are the easiest to deceive. Despite this, there are characteristic features that still indicate an artificial reality, especially for visual impressions. In addition, the reflections on a shiny surface, fog and certain light effects are getting replicated in a realistic manner [38, 39]. Increas-

ingly more new algorithms for a faster and better model of reality are being invented. The best visual impressions are now probably produced by surround cinemas and HMDs. This is where people almost have to depend on the other senses to determine whether they are in a virtual world [33]. Auditory impressions based on head related transfer functions have now become very realistic [40].

The strongest indications for a differentiation are provided by the other three senses. The sense of balance is usually not or just incompletely addressed by most VR systems. Only flight and driving simulators attempt to create a realistic impression of this balance sense; however, this is only partially successful due to the limited mechanical possibilities. A precise replication of the sense of touch is still the most difficult to create. The human sense of smell and touch has such a high resolution and is so precise that it still will not be possible to create a good simulation of it. Yet, there are virtual worlds such as flight simulators in which all objects are replicated within reach in a realistic manner so that the sense of touch is also not provided with any indications for a differentiation between the real and virtual world. But these artificial realities all serve a very special purpose. Only the replicated objects can be portrayed within reach. There are very few, highly specialised VR systems that can appeal to the sense of smell or taste [41]. The differentiation between reality and simulation is currently still very simple in most cases, in so far as a person is willing to determine this differentiation. However, we can reckon with the fact that simulations will become better in the future and that differentiation will become more difficult as a result [25].

III. Technology as Cultural Means

Learning as the realisation of new determination processes in the interaction of humans with computer only becomes cultural technology when it is accessible to [almost] everyone. The accessibility conveyed through the corresponding interaction technologies must utilise the natural potentials of the user; and this is precisely where the VR systems have their starting point. In VR systems the user should have the possibility of behaving in a way comparable to that of the real world [42]. This creates the possibility of developing a new understanding of virtual worlds, which only currently exists in this form through the expensive construction process of artificial realities. The high degree of sensory perception, interactivity and immediacy with the force of quick adaptation to the user's requirements leads to an intersubjective-communicative exchange through the world of the imagination that can be perceived with the senses for the first time in human history. The directly tangible *materialisation* of ideas will – comparable with the introduction of language – enable a new era of understanding. Consequently, virtual worlds can be meaningful in two different respects: (1.) as reconstruction machines of ideas and (2.) as a communication medium of these re-constructions. The following conclusion applies to both cases: the meaning only becomes apparent in and through the action, as shown through simulation in [43], and through a real world application in [44].

IV. References

1. Dourish, P., *Where the Action Is: The foundations of embodied interaction*. 2004, Cambridge London: MIT press.
2. Djajadiningrat, T., K. Overbeeke, and S. Wensveen, *But how, Donald, tell us how?: On the creation of meaning in interaction design through feedforward and inherent feedback*, in *Proceedings of the 4th Conference on Designing Interactive Systems: processes, practices, methods, and techniques*, B. Verplank and A. Sutcliffe, Editors. 2002, ACM: New York. p. 285-291.
3. Treisman, A., *The perception of features and objects*, in *Visual Attention*, R.D. Wright, Editor. 1998, Oxford University Press: New York - Oxford. p. 26-54.
4. Rauterberg, M. and L. Feijs, *Enhanced causation for design.* International Journal of Philosophy Study, 2015. **3**: p. 21-34.
5. Saariluoma, P. and M. Rauterberg, *Turing's error-revised.* International Journal of Philosophy Study, 2016. **4**: p. 22-41.
6. Hofstede, G.H. and G. Hofstede, *Culture's consequences: Comparing values, behaviors, institutions and organizations across nations*. 2001, Thousand Oaks London New Delhi: Sage.
7. Coll, C.G., E.L. Bearer, and R.M. Lerner, eds. *Nature and Nurture: The complex interplay of genetic and environmental influences on human behavior and development*. 2014, Psychology Press: New York London.
8. Dahlberg, W., *Zur Geometrie der Grundbegriffe (On the geometry of the basic concepts)*, in *Klassifikation und Erkenntnis (Classification and cognition)*, I. Dahlberg and W. Dahlberg, Editors. 1979, Gesellschaft für Klassifikation (Society for classification): Frankfurt.
9. Neisser, U., *Kognition und Wirklichkeit (Cognition and reality)*. 1979, Stuttgart: Klett-Cotta.
10. Piaget, J., *Le jugement et le raisonnement chez l'enfant*. 1947, Neuchatel: Delachaux & Niestle.
11. Tosa, N., *Cross-cultural computing: an artist's journey*. Springer Series on Cultural Computing, ed. E. Edmonds. 2016, Heidelberg New York: Springer Verlag London.
12. Hofstadter, D.R., *I Am a Strange Loop*. 2008, New York: Basic Books.
13. Remane, A., *Die biologischen Grundlagen des Handelns (The biological basis of acting)*, in *Handlungstheorien - interdisziplinär (Theories of action - interdisciplinary)*, H. Lenk, Editor. 1981, Fink: Munich. p. 13-56.
14. Rauterberg, M., J. Hu, and G. Langereis, *Cultural computing–how to investigate a form of unconscious user experiences in mixed realities*, in *Entertainment Computing Symposium - ECS 2010*, R. Nakatsu, et al., Editors. 2010, Springer: Heidelberg. p. 190-197.
15. Pfeifer, R., M. Lungarella, and F. Iida, *Self-organization, embodiment, and biologically inspired robotics.* Science, 2007. **318**(5853): p. 1088-1093.
16. Varela, F.J., E. Thompson, and E. Rosch, *The embodied mind*. 1991, Cambridge: MIT Press.
17. Ward, D., D. Silverman, and M. Villalobos, *Introduction: The varieties of enactivism.* Topoi - An International Review of Philosophy, 2017. **36**(in press): p. 1-11.
18. Rauterberg, M., *About a framework for information and information processing of learning systems*, in *Information system concepts: Towards a consolidation of views*, E.D. Falkenberg, W. Hesse, and A. Olivé, Editors. 1995, Chapman&Hall: London. p. 54-69.
19. Piaget, J. and B. Inhelder, *Jenseits des Empirismus (Beyond empiricism)*, in *Das neue Menschenbild (The new human image)*, A. Köster and J.R. Smythies, Editors. 1970, Molden: Vienna.
20. Schütz, A., *Der sinnhafte Aufbau der sozialen Welt (The meaningful construction of the social world)*. 1932, Vienna: Springer.
21. Mehan, H. and H. Wood, *The reality of ethnomethodology*. 1975, New York: Wiley & Sons.
22. Piaget, J., *Intellectual evolution from adolescence to adulthood.* Human Development, 1972. **15**(1): p. 1-15.
23. Oerter, R., *Wissen und Kultur (Knowledge and culture)*, in *Wissenspsychologie (Psychology of knowledge)*, H. Mandl and H. Spada, Editors. 1988, Psychologie Union: Munich. p. 333-356.
24. Lenk, H., *Handlung als Interpretationskonstrukt (Action as an interpretation construct - Philosophy of action)*, in *Handlungstheorien - interdisziplinär (Theories of action - Interdisciplinary)*, H. Lenk, Editor. 1978, Fink: Munich. p. 279-350.
25. Irwin, W., ed. *The matrix and philosophy: Welcome to the desert of the real*. Popular Culture and Philosophy. Vol. 3. 2002, Open Court Publishing: Illinois.

26. Bartneck, C. and M. Rauterberg, *HCI reality—an 'Unreal Tournament'?* International Journal of Human-Computer Studies, 2007. **65**(8): p. 737-743.
27. Song, H., et al., eds. *Cyber-Physical Systems - Foundations, Principles and Applications*. Intelligent Data-Centric Systems, ed. F. Xhafa. 2017, Elsevier-Academic Press: Amsterdam New York London Sydney.
28. Bartneck, C., et al., *Applying virtual and augmented reality in cultural computing.* International Journal of Virtual Reality, 2008. **7**(2): p. 11-18.
29. Urech, S., *Reale versus virtuelle Welten (Real versus virtual worlds)*, in *Technical Report VR-1-92*. 1992, Institute for Work Psychology, Swiss Federal Institute of Technology: Zurich.
30. Ishida, T., *Digital city Kyoto.* Communications of the ACM, 2002. **45**(7): p. 76-81.
31. Nakatsu, R., *Logos, pathos, and entertainment*, in *Culture and Computing*, T. Ishida, Editor. 2010, Springer: Heidelberg. p. 137-146.
32. Nijholt, A., ed. *Playful User Interfaces: Interfaces that invite social and physical interaction*. 2014, Springer Science & Business Media: Singapore. 352.
33. Altman, E. and R. Nakatsu, *Interactive movies: Techniques, technology and content*, in *ACM SIGGRAPH Course Notes 16*. 1997, ACM: New York.
34. Milgram, P. and F. Kishino, *A taxonomy of mixed reality visual displays.* IEICE Transactions on Information and Systems, 1994. **E77-D**(12): p. 1-15.
35. Krueger, M.W., *Artificial Reality*. 1983, Reading: Addison Wesley.
36. Memoli, G., et al., *Metamaterial bricks and quantization of meta-surfaces.* Nature Communications, 2017. **8**(online): p. 14608.
37. Peddie, J., *Augmented Reality - Where we will all live*. 2017, Cham: Springer International Publishing AG.
38. Watanabe, Y. and Y. Suenaga, *Drawing human hair using the WISP model.* The Visual Computer, 1991. **7**(2-3): p. 97-103.
39. Pueyo, X., *Diffuse interreflexion techniques for form-factor computation: A survey.* The Visual Computer, 1991. **7**(4): p. 200-209.
40. May, T., S. van de Par, and A. Kohlrausch, *A probabilistic model for robust localization based on a binaural auditory front-end.* IEEE Transactions on Audio, Speech, and language Processing, 2011. **19**(1): p. 1-13.
41. Salem, B., R. Nakatsu, and M. Rauterberg, *Kansei experience: aesthetic, emotions and inner balance.* International Journal of Cognitive Informatics and Natural Intelligence, 2009. **3**(2): p. 18-36.
42. Rauterberg, M., *From personal to cultural computing: how to assess a cultural experience*, in *uDayIV–Information nutzbar machen*, G. Kempter and P.v. Hellberg, Editors. 2006, Pabst Science Publisher: Lengerich. p. 13-21.
43. Olier, J., et al., *Re-framing the characteristics of concepts and their relation to learning and cognition in artificial agents.* Cognitive Systems Research, 2017. **44**: p. 50-68.
44. Olier, J.S., et al., *Dynamic representations for autonomous driving*, in *Proceedings of IEEE Conference on Advanced Video and Signal Based Surveillance - AVSS*, C. Distante and L.S. Davis, Editors. 2017, IEEE & EU: Piscataway. p. in press.