Chapter 9
Understanding Simulation Validation—The Hermeneutic Perspective

Nicole J. Saam

Abstract The thesis of a hermeneutic perspective on validation in simulation has existed ever since Kleindorfer et al. (*Manag Sci* 44:1087–1099, 1998) published their overview of various positions in the philosophy of science. This chapter introduces the distinction between a hermeneutics *in* validation and a hermeneutics *of* validation. I argue that the hermeneutic perspective according to Kleindorfer, O'Neill and Ganeshan, which qualifies as a hermeneutics *in* validation perspective, is rather fruitless. Instead, a hermeneutics *of* simulation validation is proposed on the basis of Gadamer's philosophical hermeneutics. The goal of the hermeneutics *of* validation is to understand simulation validation. The challenge is to set up a hermeneutic situation in the first place. Hermeneutic aims to demonstrate how simulation validation is historically situated, revealing the hidden prejudice (prejudgement) in validating, and distinguishing between legitimate prejudice and prejudice that has to be overcome. Understanding simulation validation is a dialogic, practical, situated activity.

Keywords Simulation validation · Philosophical hermeneutics · Understanding · Interdisciplinary dialogue

9.1 Introduction

In 1998, Kleindorfer et al. (1998) published an article in which they examined how well various positions in philosophy of science can account for validation of computer simulations. Remarkably, they not only considered standard positions from the history of philosophy, such as rationalism and classical empiricism, or from more recent, analytical philosophy such as logical positivism, diverse falsificationist positions, Kuhnianism and Bayesianism. Rather, they ended up favouring a hermeneutic perspective on the validation of simulations. Hermeneutics is presented as a solution

N. J. Saam (✉)
Institut für Soziologie, Friedrich-Alexander-Universität Erlangen-Nürnberg, Erlangen, Germany
e-mail: nicole.j.saam@fau.de

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to the debate between objectivists and relativists—a debate which they consider to be 'the underlying plate tectonics in the simulation validation problem' (Kleindorfer et al. 1998, p. 1088). Naylor and Finger's (1967) article is presented as the classic view of positive simulation validation, which they term 'objectivist', while Barlas and Carpenter's (1990) article is presented as the 'relativist' antithesis, drawing on the philosopher Thomas Kuhn (1970). Kleindorfer et al. (1998) follow American philosopher Bernstein (1983) in arguing that there is a Cartesian legacy in the debate, stating that 'many simulation modellers apparently believe that model validation is an 'either/or' proposition' (Kleindorfer et al. 1998, p. 1088), and they seek a means for breaking out of this dichotomy. Following Bernstein, they present the hermeneutics of German philosopher Hans-Georg Gadamer as 'a philosophical fulcrum' for transcending the objectivist versus relativist debate (p. 1097). They argue that whereas, in general, philosophy of science has begun to turn away from the Cartesian legacy, the discussion of simulation validation still assumes an 'either/or' situation. In this state of affairs, Kleindorfer et al. (1998, p. 1087) 'set out a perspective'. The hermeneutic position is favoured, since it refers to Ancient practical wisdom (*phronesis*) and requires that practitioners conduct 'meaningful dialogue on a model's warrantability' (Kleindorfer et al. 1998, p. 1098).

While this article is much quoted and its statements on the hermeneutic account have often been reproduced, it has never been discussed or elaborated upon in depth. A description of the hermeneutic approach has yet to be extended beyond the initial sketch of two pages. Meanwhile, the state of two other related philosophical debates is unfavourable for hermeneutics: (1) the much broader attempt to establish a hermeneutics of the natural sciences (e.g. Crease 1997; Heelan 1998; Feher et al. 1999)—separately from a Kuhnian history of science perspective—seems to have failed, as the articles by Markus (1987), Eger (1997) and Kisiel (1997) indicate. Most recently, this failure is reflected in the lack of a chapter on hermeneutics and the natural sciences in part IV, 'Hermeneutic Engagements', of Malpas and Gander's (2014) *Routledge Companion to Hermeneutics*. (2) The current philosophical debate on understanding simulation models (Humphreys 2004, 2009; Reutlinger et al. 2018; Saam 2017) refrains from any reference to hermeneutic perspectives—whether traditional or modern, although understanding is a topic at the centre of hermeneutics. Responding to this state rather reminiscent of a standstill or even a drawback of hermeneutics as applied to (natural) science or scientific methods, this chapter discusses the fruitfulness of a hermeneutic perspective on validation in simulation.

To this end, I first introduce the distinction between a *hermeneutics in validation* and a *hermeneutics of validation* (Sect. 9.2). I then show that the perspective of a hermeneutics *in* simulation validation as proposed by Kleindorfer et al. (1998) is rather fruitless by arguing that their perspective rests on conditions that are not fulfilled and on some misunderstandings (Sect. 9.3). I proceed by introducing the perspective of a hermeneutics *of* simulation validation. Connecting Gadamer's (2013 [first German edition 1960]) philosophical hermeneutics and his ideas of prejudice (German *Vorurteil;* please note that Gadamer has a positive conception of prejudice in terms of prejudgment), circularity and historicity to insights from the hermeneutics of the natural sciences discourse, I argue for four claims of a hermeneutics of

validation: understanding simulation validation requires the setup of a hermeneutic situation. The simulating scientist shows a hermeneutic naiveté vis-à-vis her validation practices, as opposed to the philosopher of science and the methodologist. This naiveté is overcome in interdisciplinary dialogue. Major hermeneutic tasks are showing how simulation validation is historically situated, revealing the hidden prejudices in validating, as well as distinguishing legitimate prejudice from the prejudice that has to be overcome (Sect. 9.4). In the discussion, I consider the limitations to, and the significance of, a hermeneutics *of* validation (Sect. 9.5). The conclusion suggests issues for future hermeneutic dialogues.

This chapter uses Schlesinger's SCS definition of model validation ('*the substantiation that a computerized model within its domain of applicability possesses a satisfactory range of accuracy consistent with the intended application of the model*'; Schlesinger 1979, p. 104) as a point of reference for defining simulation validation. Prior to any further analysis, this definition offers no idea of how a hermeneutic perspective might contribute to simulation validation.

9.2 Hermeneutics *in* Versus Hermeneutics *of* Validation

In this chapter, hermeneutics will be used to refer to a philosophical discipline concerned with analysing the conditions of understanding. Hermeneutics emerged as a crucial branch of text studies. Later on, it came to include the study of ancient and classic cultures, as well as of day-to-day life, and existence as such. As Ramberg and Gjesdal (2005) emphasize, the term *hermeneutics* covers both the art of understanding and interpretation of linguistic and non-linguistic expressions (call this first-order hermeneutics) as well as the theory thereof (second order). As a philosophical discipline, based on Gadamer's (2013) account of hermeneutics, three levels may be distinguished: hermeneutics as an art aiming at the understanding (1) of any kind of text; (2) of human life in general, in particular as takes place in language and (3) of existence as such. All understanding is, according to Gadamer, interpretative, i.e. disclosure of meaning.

It is important to understand Gadamer's concept of text. He uses text as a model. Everything is mediated in the universal medium of language. In everyday life, 'text' refers to an object that can be read, something written. A broader understanding of the text recognizes that everything that is mediated in the universal medium of language—utterances, verbal communication, e.g. regarding simulation validation practices, even thoughts—can be transformed into text. Texts can be seen as objectifications of human experience. Finally, all of human life that takes place in language can be studied as text. In this way, Gadamer uses the textual model to develop his hermeneutic conception, which is by no means restricted to 'texts' alone. The concept of validation texts referred to below is based on this Gadamerian understanding of text and includes not only any sort of text, such as textbooks or scientific articles on simulation validation, but all sorts of validation practices and validation knowledge which are mediated in the medium of language. In the same way, the endeavour of

Table 9.1 Hermeneutics *in* versus hermeneutics *of* validation

	Hermeneutics *in* validation	Hermeneutics *of* validation
Object to be understood	Simulation models and their results relative to target	Simulation validation procedures and related practices
Question	How can the model and its results be validated?	How can simulation validation be understood? How are acts of understanding involved in the validation of models and their results?
Interpreter	Working scientist	Philosopher of science, methodologist, working scientist
Hermeneutics applied	First-order art	First-order art and second-order theory

understanding simulation validation is not restricted to the means of reading literature on validation.

If we want to apply the hermeneutic perspective to simulation validation this, therefore, means asking how understanding is related to it. Here, I introduce a major distinction (see Table 9.1): the difference between a 'hermeneutics *in*' and a 'hermeneutics *of*' addresses the position of the interpreter. If the interpreter is a simulation scientist who uses the hermeneutic perspective *when validating* her simulation model, we shall refer to this as hermeneutics *in* validation (asking the question of how the model and its results can be validated). This situation has to be distinguished from a hermeneutic perspective that is taken from the position of an observer. Philosophers of science, methodologists or simulating scientists then *reflect* on simulation validation in order to understand this scientific activity and its related practices (asking the question of how simulation validation can be understood). Revisiting Ramberg and Gjesdal's distinction (2005), 'hermeneutics *in*' refers to the first-order art while the 'hermeneutics *of*' validation refers to the second-order theory of understanding and interpretation.

9.3 Hermeneutics *in* Validation

The first attempt to outline a hermeneutic position in simulation validation was presented by Kleindorfer et al. (1998), based on a conference paper by Kleindorfer and Geneshan (1993), and qualifies as a hermeneutics *in* validation perspective.

In the following, I reconstruct their claims in Sect. 9.3.1. In Sect. 9.3.2, I interpret their outline as an effort to directly apply hermeneutics to validation. I argue that this effort is rather fruitless, since their perspective rests on conditions that are not given or are based upon some misunderstandings. The second option would be to

apply hermeneutics in the sense of seeking analogies. However, there prove to be important disanalogies. This raises the question of whether the remaining claims are essentially hermeneutic or rather are supported by different philosophical perspectives too (Sect. 9.3.3).

9.3.1 Hermeneutics According to Kleindorfer, O'Neill and Ganeshan

In their article, Kleindorfer et al. (1998) provide a description of various philosophical positions and summarize the problems and the kinds of arguments these positions each allow in arriving at defensible simulation models. The motivation for Kleindorfer et al. (1998, p. 1087) philosophical sketch is a perceived 'doubt and even anxiety among simulation modellers as to what the methodologically correct guidelines or procedures for validating simulating models should be'. Referring to Bernstein (1983), they describe this anxiety as Cartesian. It is related to an *either (confirmed)/or(refuted)* distinction in validation, while in practice confirmation is a matter of degree. As Oreskes et al. (1994, p. 643) emphasize: 'In practice, few (if any) models are entirely confirmed by observational data, and *few* are entirely refuted'. Kleindorfer et al. (1998, p. 1087) intention is to 'free the practitioner to pursue a varied set of approaches to validation with diminished burden of methodological anxiety'. Consequently, they do not prescribe a particular technique or algorithm, but offer hermeneutics as a perspective that frees the validating simulation scientist.

These statements resonate with Gadamer's (2013) major theme in his most important book *Truth and Method*. There, he developed his philosophical hermeneutics which provides an account of the proper grounds for understanding. He rejects the attempt to found understanding on any ('scientific') method or set of rules, arguing that there is no methodology that describes the means by which to arrive at an understanding of human life. Neither is there any such methodology that is adequate for understanding nature. Insisting on the limited role of method, he emphasizes that understanding is a dialogic, practical, situated activity. It seems plausible that Kleindorfer, O'Neill and Ganeshan felt attracted by Gadamer's claim concerning the limited role of method and the priority that should be given to dialogue.

Kleindorfer et al. (1998, p. 1090) summarize their paper by saying that the epistemological focus of hermeneutics rests on interpretation and understanding through dialogue and practice.[1] They contrast the epistemological focus of hermeneutics to

[1]The presentation of the hermeneutic perspective on simulation validation by Kleindorfer et al. (1998, pp. 1096–1098 and one row in Table 9.1, p. 1090) amounts to no more than two pages in total. Gadamer's hermeneutics as put forward in *Truth and Method* (Gadamer 2013 [original 1960]) serves as a major reference, although it is the reading of Gadamer's hermeneutics by Bernstein (1983) which the authors actually adopt. This becomes explicit on p. 1098, where they refer to 'Bernstein's hermeneutics'. They introduce Bernstein as a philosopher who presents Gadamer's hermeneutics as a philosophical fulcrum for transcending the polarity of the foundationalist versus anti-foundationalist debate. The authors apply Bernstein's hermeneutics to validation in simula-

other foci: the logical justification of knowledge claims (attributed to rationalism, classical empiricism, logical positivism), theories as frameworks for prediction and testing (instrumentalism, dogmatic and methodological falsificationism) , consistent treatment of probabilistic induction (Bayesianism) and progressive historical growth of knowledge (Kuhnianism, Lakatos' methodology of scientific research programmes).

In order to facilitate the discussion of Kleindorfer, O'Neill and Ganeshan's hermeneutic perspective on simulation validation, I will now reconstruct their most important statements in five claims. First of all, Kleindorfer, O'Neill and Ganeshan emphasize the contribution that openness and reason make to the growth of knowledge. This claim is transferred to simulation validation. They put forward claim C-Open to address the issue of openness:

C-Open: the model builders are free to establish and increase the credibility of the model by any reasonable means.

Kleindorfer et al. (1998, p. 1098) state that the validation of a model can be achieved in any reasonable manner, and they explain that by reasonable means/manner they mean 'historically situated dialogue, judgment and practical discourse'. This openness includes, for instance, the possibility of meaningfully comparing different models and the involvement of further model stakeholders. They refer back to Bernstein's concept of rationality, which they describe as 'historically situated and practical, involving choice, deliberation and judgement' (Kleindorfer et al. 1998, p. 1097), and to *phronesis*, the term that Aristotele—and Gadamer and Bernstein—used for 'practical wisdom'. A mere glance at Bernstein's (1983) final part IV reveals that the concept of judgment refers to the political philosophy of Hannah Arendt, developed in particular in *The Human Condition* (1958), and that the concept of practical discourse alludes to the discourse theory of Habermas (1984, 1996). Kleindorfer, O'Neill and Ganeshan claim that practical judgement and interactive orientation bring an ethical dimension to scientific validation. They contend that in this way 'we are able to discern the difference between the good and the bad, the worthwhile and the frivolous, the "true" and the "false"' (Kleindorfer et al. 1998, p. 1098). They claim that human judgement and decision enter the process of validation; judgement and decision making cannot be avoided. Quoting Forrester (1961, p. 118), they argue that a choice is made concerning that part of the available knowledge that is to be relied upon. As an example, they turn to the court system, putting forward claim C-Court:

C-Court: the court system is a framework for simulation validation consistent with Bernstein's hermeneutics.

Kleindorfer, O'Neill and Ganeshan argue that to obtain a conviction the guilt of the defendant does not have to be proved. Rather, guilt would have to be established beyond reasonable doubt. Biases and prejudice on the part of the jurors would presumably contribute to what is considered to be 'reasonable'. In the next paragraph,

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tion, taking two quotations from Barlas and Carpenter (1990) and Carson (1989) to support their arguments.

they describe the court as a model or metaphor (Kleindorfer et al. 1998, p. 1098). They relate the court metaphor to the openness of the meaningful dialogues on a model's warrantability. They put forward claim C-Part to address the involvement of further model stakeholders beyond the model builders such as the model users and referees of journal articles:

C-Part: the simulation validation procedure favoured by hermeneutics is based upon participation by all interested in the outcome.

Notably, Kleindorfer, O'Neill and Ganeshan's hermeneutic perspective on validation does not rest on the concept of the so-called hermeneutic circle.[2] However, they connect the hermeneutic circle to their concept of understanding simulation results:

C-HC: in simulation we experience cognitive processes as described by the hermeneutic circle.

Kleindorfer et al. (1998, p. 1097) argue that in simulation, there is a persistent play back and forth 'whereby our understanding of general principles is increased as we interpret the particulars in a given application. In the light of that understanding, we simultaneously begin to see the particulars more sharply and are better able to give them meaning'. The term 'general principles' is not specified and may serve as a substitute for the principles governing the modelled system as a whole. Immediately after this statement, they turn to the metaphor of play. They seem to refer to a familiar saying of modellers who describe aspects of their scientific work in simulation as 'playing' with a theory or model. Without any further explanation, they report on the recognition that this 'playing' is perceived as a way of effecting model validation:

C-Play: 'playing' with a theory or simulation model is a way of effecting its validation.

The presentation of Kleindorfer, O'Neill and Ganeshan's hermeneutic perspective by Feinstein and Cannon (2003) basically repeats these claims.

9.3.2 A Reply to Kleindorfer, O'Neill and Ganeshan

Before we discuss the claims C-Open through C-Play, two preliminary remarks seem necessary. They address (i) the theoretical status of the 'hermeneutic position' and (ii) the lack of elaborate claims.

(i) Kleindorfer et al. (1998) seem hesitant to establish a genuine philosophical position. While they announce in the abstract that they will 'set out' a hermeneutic

[2]Several formulations of the term 'hermeneutic circle' are known. The classic notion refers to the back-and-forth movement of thought from the whole to a part of the object of investigation and back to the whole again, each new understanding of the latter modifying the understanding of the former, and vice versa. The objective is to recover the meaning of the object of the investigation.

perspective, they write in the introduction that they will 'describe' the implications of hermeneutics to the validation problem in simulation. Altogether, it strikes me that Kleindorfer et al. (1998) use the subjunctive in establishing their claims C-Open, C-Court and C-Part ('The hermeneutic position would assert… would be consistent with … would be free … would not preclude'), while the indicative mode is used within claims C-HC and C-Play. This gives the sketch of the hermeneutic position an ambiguous status. I have decided to adopt the theoretical claim of Bernstein's hermeneutics on which Kleindorfer, O'Neill and Ganeshan rely to gain a definite philosophical position wherever the subjunctive mode is used by the authors. Consequently, I take the respective claims (C-Open, C-Court and C-Part) to be descriptive sentences. In contrast, recognizing that the authors are social scientists, I consider claims C-HC and C-Play to be empirical sentences.

(ii) In the absence of elaborate claims, one argument is always pertinent, but not scientifically fruitful: Kleindorfer, O'Neill and Ganeshan's claims could be rejected because they are explained in insufficient fashion and are much too general. I will follow a different path. My objections will be based on an effort to provide at least some missing explanations in the light of the few hints that Kleindorfer, O'Neill and Ganeshan give. I have chosen this approach in order to begin the discussion of their theses, which is still lacking. Ultimately, my criticism addresses my own reconstructions of what Kleindorfer, O'Neill and Ganeshan have argued, based on Bernstein (1983) as my primary source, since he obviously also served as such for Kleindorfer, O'Neill and Ganeshan. As my goal is not to elaborate Kleindorfer, O'Neill and Ganeshan's hermeneutic perspective, I will try to keep it brief and only provide the relevant link to Bernstein's hermeneutics.

9.3.2.1 Dialogue, Judgment and Practical Discourse (C-Open)

To begin with, I do not wish to refute claim C-Open in general. I recognize that historically situated dialogue, judgment and practical discourse may have the liberating effect the authors seek to highlight. However, I disagree with subsuming all three procedures under a hermeneutic position. While the authors seem to follow Bernstein (1983, e.g. p. 110, 112, 176, 219, 229), who argues in favour of the convergence of Gadamer's hermeneutics, Habermas' discourse theory and Arendt's political philosophy, I contend that the latter two have objected to basic hermeneutic assumptions (see the Gadamer Habermas debate; for a recent review of that debate and its outcomes see Smith 2014) or have taken their inspiration from Kant's *Critique of Judgment* (Arendt) such that the force of the better public argument that they support is not founded on a hermeneutic position. Thus, these thinkers recommend judgment and practical discourse from other philosophical positions beyond hermeneutics. Judgment and practical discourse are not only recommended from a hermeneutic position.

What I miss in relation to claim C-Open is any explanation as to when either historically situated dialogue, judgment or practical discourse may be suitably applied to simulation validation. Are they all reasonable for every problem it entails? This point also holds for the contention that practical judgment and interactive orientation provide an ethical dimension to the practice. When and how can the 'good and the bad' be discerned? What does 'the worthwhile and the frivolous' mean? Why is 'the "true" and the "false"' placed in quotation marks? What practical wisdom is required and applied? While Kleindorfer, O'Neill and Ganeshan quite convincingly relate particular problems in simulation validation to other philosophical positions described and discussed in their previous sections, they do not relate any distinct problem to the application of their hermeneutic position. It seems that there is no problem for their proposed new perspective—apart from the very general Cartesian anxiety. It thus seems that claim C-Open is too broad to give useful advice to practitioners. To illustrate my counterargument, I look more closely at the conditions of the possibility of achieving the validation of a model via historically situated dialogue.

Against claim C-Open, I contend that Gadamer's conditions to enter into the dialogue with the matter at issue are *not* fulfilled in simulation validation practice. In simulation validation, the situatedness is bracketed: according to Gadamer, all understanding directed at the grasp of some particular subject matter is based on a prior understanding—a prior hermeneutic situatedness. There are always 'fore-structures' of understanding, meaning anticipatory structures that allow what is to be interpreted or understood to be grasped in a preliminary fashion. This situatedness is historically determined. However, a reflexive hermeneutic awareness of this historically determined situatedness may be lacking—a situation which has been called 'historical amnesia' by Markus (1987). who had observed that natural scientists are acculturated to write their reports with a depersonalized objectivity that decontextualizes the situational contingencies. 'Bluntly put, the natural sciences, in practice, seem to be in no need of a hermeneutics—they succeed quite well without it' (Markus 1987, p. 8). Two important reasons he presents as to why this should be so are: (1) the success of the practice very much depends on tacit knowledge that is incorporated, e.g. in laboratory activities. There is no pragmatic benefit in reflecting on the implicit hermeneutics operative in these craft skills. (2) Traditions embodied in validation terminology and methods are subject to an accelerated rate of obsolescence, rendering the use of Gadamer's concept of tradition shallow. Markus (1987, p. 46) concludes in his analysis that 'a *reflexive* hermeneutic awareness [is] unnecessary for the successful practice of the natural sciences'. Suppose that a hydrologist evaluates the validity of her groundwater flow simulation model's results (see Chap. 27 by Roache in this volume). She compares the model results and their uncertainties with observational (often experimental) results and their uncertainties. She considers the errors in the simulation result and the experimental result. She reflects on the proposed purpose and domain of applicability of her model. In these evaluations, she will neither consider how the concepts of water and velocity she refers to are historically situated, nor will she reflect on how her concepts of uncertainty and error and her observational methods are historically situated. Instead, the final judgment on the validity of the hydrological model's results will be based on having bracketed

these questions. Former methods and techniques of validation, as well as historical concepts of water and velocity, are irrelevant for her present evaluation, because the model assumptions are based on one, present, state-of-the-art concept of water and assumptions from computational physics. The irrelevance of historical concepts of water and velocity is a consequence of the underlying rules of model construction. In one and the same model, a certain theoretical concept should only be defined and implemented in one and the same way (and if this rule is violated during model construction, it is a task for the validator to find that mistake). The validation of this model's results depends on validation methods and techniques that primarily reflect the state of the art and only secondarily on the history of scientific methods. Validation of a model is not achieved via historically situated dialogue—which might indeed free the hydrologist to pursue a varied set of approaches to validation with diminished burden of methodological anxiety—rather it is achieved via thorough evaluations that reflect the state of the art in the methods and techniques that are applied. Stating this, I do not question that dialogue is historically situated. It is. I only argue that the conditions for the possibility of a dialogue are not fulfilled.

Additionally, I point to what I want to call the social scientific misunderstanding of dialogue. Kleindorfer et al. (1998) seem to assume that dialogue requires the discursive encounter of scientists. However, Gadamer's concept of dialogue is philosophical and much broader. It requires an interpreter and a text. To Gadamer, a dialogue is not necessarily a social encounter. This misunderstanding is relevant in Kleindorfer et al. (1998) claims C-Open and C-Court. In their interpretation of the court system as a model and of the court metaphor it becomes obvious that they put forward a social concept.

9.3.2.2 The Court System and Its Openness (C-Court)

At the centre of their court system claim is the justification of validity claims—a major topic in the Habermasian discourse model—and not the Gadamerian idea of pluralistic dialogue between different horizons. Kleindorfer, O'Neill and Ganeshan do not aim at an understanding that occurs as a hermeneutic 'fusion of horizons', nor do they—as Gadamer does—envision a process in which the subject is altered (because the interpreter's horizon is enlarged and enriched). It is not sufficient, however, to claim C-Court. Kleindorfer, O'Neill and Ganeshan's claim is much better suited to Habermas' than to Gadamer's model.

The court metaphor contradicts Kleindorfer, O'Neill and Ganeshan's assumption of an openness in which meaningful dialogue can be conducted. As Doublet (2003, p. 62) argues, legal hermeneutics is dogmatic. There is an authorized interpretation of law from the side of the legislator. Although modern legal hermeneutics also acknowledges alternative perspectives such as textualist accounts (see e.g. Poscher 2014), so-called intentionalist accounts of legal interpretation remain a strong current. This raises doubt as to whether the court metaphor—which is a vague conceptualization anyway—can serve as a framework for simulation validation and warrant the favoured openness.

Not legal (i.e. a hermeneutics directed to the understanding of legal texts), but social science hermeneutics (directed to the understanding of social action) may be applied in court when actions, statements or motivations of the accused person are interpreted. Social science hermeneutics, for which I prefer to use the concept of sociology of understanding, may be considered to be more open-ended than legal hermeneutics. However, it seems that Kleindorfer et al. (1998, p. 1098) rather have in mind legal hermeneutics, as their summarizing statement shows: 'By and large, it is the merits of the case as defined within the parameters of the law that determine a trial's outcome'.

9.3.2.3 Participation and Judgement (C-Part)

Claim C-Part calls for the participation of all who are interested in the outcome—the stakeholders, to use a modern term. Indeed, there are stakeholder approaches to simulation validation, however, these approaches are restricted to action research v and to particular conditions that have been explained based on a pragmatic perspective: action researchers consider the ways in which social reality is an ongoing accomplishment of social actors rather than something that is external to them and that totally constrains them. In particular, social realities are perceived as being local, specific and socially constructed. The local community whose problem is being addressed by the action research is considered to be experts on their own experience. Their local knowledge is explored through communication with the action researcher (see Chap. 17 by Saam in this volume). Kleindorfer, O'Neill and Ganeshan do not provide any specification or qualification addressing social reality as an ongoing accomplishment of social actors. If they had such a constructionist perspective, they would have to make explicit: what is the knowledge which is contributed by the stakeholders to simulation validation? What is its epistemic state compared to the knowledge of the simulating scientist? When should this knowledge be contributed? What are the conditions for the participation of the stakeholders?

Ultimately, claim C-Part seems to be an adaptation of Hannah Arendt's political philosophy as discussed by Bernstein (1983, pp. 210–221). Interested in politics and the public sphere, she contends that each person must be given the opportunity to participate in politics (Arendt 1969, p. 233). A second source is Gadamer's hermeneutics (Bernstein 1983, p. 137). However, it is in Arendt's *Crisis of the Republic* that (political) judgment and participation are related (see the discussion in Bernstein 1983, pp. 207–223). The question of how Arendt's analysis of judgment as an intrinsically political mode of thinking can be transferred to simulation validation is not addressed by Kleindorfer, O'Neill and Ganeshan. As the criterion of equality among citizens cannot simply be transferred from politics to science, the claim is not convincing without further explanation.

9.3.2.4 The Hermeneutic Circle (C-HC)

Claim C-HC is related to simulation validation in an indirect way. Understanding simulation results may be considered a necessary condition for the validation of simulation models and their results. I want to point out that Kleindorfer, O'Neill and Ganeshan's claim is based on an insufficient application of Gadamer's concept of the hermeneutic circle. I do not deny that there is some type of circularity in understanding simulation results. I agree that simulation scientists improve their understanding of the model's results based on their foreknowledge that directs the specification of further simulation experiments. But I am hesitant to apply Gadamer's concept of prejudice and understanding here. What is essential for Gadamer's understanding of the hermeneutic circle is that the hidden prejudice—the kind of prejudice really relevant to hermeneutics—is effective for us via history. Prejudice is revealed as prejudice only in the encounter with tradition. Gadamer (2013, p. 310) argues that 'Understanding is, essentially, a historically effected event'. The cognitive processes described by Kleindorfer, O'Neill and Ganeshan lack this historical dimension. The encounter with my foreknowledge prior to the previous simulation runs is not an encounter with tradition. Second, the understanding that results from this encounter is not a hermeneutic understanding. According to Gadamer, all understanding is disclosure of meaning (*Sinn*). But understanding simulation results are not related to conceiving the meaning of some sort of results. Rather, understanding simulation results is related to giving well-founded answers to what-if-things-had-been-different questions (Saam 2017) or grasping the model (Reutlinger et al. 2018). Thus, while there is some type of circularity in understanding simulation results, this understanding does not qualify as *hermeneutic* understanding and it is not based on the *hermeneutic* circle.

9.3.2.5 Play (C-Play)

In claim C-Play, play is used as a metaphor. It can best be explicated by Bernstein's preferred understanding of play as a 'to-and-fro movement' (Bernstein 1983, p. 121, 171), which he takes from one of Gadamer's analyses of play. I do not deny that there is some sort of to-and-fro movement from simulation results to target, and vice versa, as well as from simulation model to theory, and vice versa, in simulation validation. In simulations that are not based on theory, there may also be such a to-and-fro between model assumptions and experimental results. However, even in this explicated way the claim is much too vague to contribute to a hermeneutics *in* validation, all the more so because the concept of play is not prominent in hermeneutics and cannot be reduced to a to-and-fro movement. Hence, while I do not wish to deny that there is some element of play in simulation (see Saam and Schmidl 2018), I claim that C-Play is inadequate for describing empirical validation practice.

Altogether, Kleindorfer, O'Neill and Ganeshan's sketch of a hermeneutic perspective *in* validation is not convincing. My claim is that the Habermasian discourse model (Habermas 1984, 1996) fits their basic intention much better. This

discourse model relies on the force of the better argument among all competent on an issue. It explicitly addresses validity claims and conforms with claim C-Open. Thus, core features outlined by Kleindorfer et al. (1998), such as openness, rationality, judgment, understanding, interpretation, participation and critique, characterize the Habermasian model.

I consider the perspective of a hermeneutics *in* simulation validation as proposed by Kleindorfer et al. (1998) to be rather fruitless, since their perspective rests on conditions that are not given and based upon some misunderstandings. Gadamer's philosophical hermeneutics provides neither a logical justification of knowledge claims, nor theories as frameworks for prediction, testing or probabilistic induction. In contrast to logical positivism, variants of falsificationism (see Chap. 6 by Beven in this volume) and Bayesianism (see Chap. 7 by Beisbart in this volume), its contribution is limited to the level of second-order reflexion. If hermeneutics can make a contribution to simulation validation, it must be on another level. In Sect. 9.4, I will therefore propose a hermeneutics *of* validation.

9.3.3 Claim C-Open—A Second View

To reiterate, I do not seek to refute claim C-Open in general. Notably, Gadamer's (2013) refusal to found understanding on any ('scientific') method or set of rules has some parallel in Feyerabend's (1975) polemic *Against Method*. Thus, the claim that the model builders are free to establish and increase the credibility of the model by any reasonable means is supported by different philosophical perspectives. I recommend seeking support and evidence for this claim from different philosophical perspectives, rather than subsuming it too superficially under a hermeneutics *in* validation or an epistemic anarchism *in* validation. The claim has a liberating effect; the more so the better we understand when and why it is supported.

9.4 Hermeneutics *of* Validation

I take Gadamer's (2013 [1960]) hermeneutics as a starting point for a hermeneutics *of* validation because in his philosophical hermeneutics he establishes a claim to the universality of hermeneutics. As Steinmann (2007, p. 102) has put it, Gadamer's claim as to the universality of hermeneutics indicates the attempt to establish hermeneutics as a 'radically modern epistemology' . According to Gadamer, science, but also art, culture, history and philosophy, comes to understanding only in the universal medium of language. Gadamer (2013, p. 491) postulates that 'man's relation to the world is absolutely and fundamentally verbal in nature, and hence intelligible'. Following Heidegger, he perceives language as a universal ontological structure. Language is 'the basic nature of everything towards which understanding can be directed' (Gadamer 2013, p. 490). Understanding is the ever-present enactment structure of

human life, the very mode of human existence. Understanding has to be considered a basic hermeneutic experience, founding all kinds of cognition and their respective ways of knowing and acting. Although Gadamer often refers to the example of understanding a text, his approach is by no means restricted to texts alone. Rather, it holds for everything within the limits of possible human experience. For Gadamer, understanding is not just a kind of knowledge specific to the human sciences. He rejects the methodological reduction and limitation by traditional hermeneutics (up to and including Dilthey). Understanding is '*a universal aspect of philosophy*' (Gadamer 2013, p. 491).

In this way, simulation validation too can become the focus of understanding. Following the distinction of levels in Sect. 9.2, the hermeneutics *of* validation considers validation as a human activity which is linguistically mediated. This practice can be understood referring to the hermeneutics of levels (1) and (2), as introduced in Sect. 9.2 above. I adopt Gadamer's basic hermeneutic ideas of *prejudice*, *circularity* and *historicity*.

In elaborating on this hermeneutic perspective, I first include some findings from the research on a hermeneutics of the natural sciences. Second, there has been a tendency to dissolve hermeneutics and to reduce it to a Kuhnian history of science perspective (see for instance, the last section in D'Agostino 2014) or to a social constructivist or cultural studies of sciences perspective (see the review by Kisiel 1997). My aim is to conserve the originality of the hermeneutic perspective. Gadamer emphasized that he sought to investigate the conditions of possibility for understanding as such.

In the following, I will elaborate four theses: (1) Understanding simulation validation requires a hermeneutic situation. (2) Simulation scientists show a hermeneutic naiveté vis-à-vis their validation practices. (3) Interdisciplinary dialogue constitutes a hermeneutic situation in which the hermeneutic naiveté is lost. (4) Hermeneutic tasks are: showing how simulation validation is historically situated, revealing the hidden prejudices in validating and distinguishing between legitimate prejudice and prejudice that has to be overcome.

As indicated in Sect. 9.2, I will distinguish three groups of interpreters: simulation scientists, methodologists and philosophers of science.

9.4.1 The Requirement of a Hermeneutic Situation

A hermeneutics *of* validation requires the setup of a hermeneutic situation, in Gadamer's definition (2013, pp. 316 f.), a situation in which we encounter the past having to understand the tradition from which we come (such as the concept of text—see Sect. 9.2 above—the concept of the past can be understood in a broad way. For example, in his hermeneutics of conversation, Gadamer describes how two speakers, say ego and alter, exchange opinions and try to understand each other. Ego tries to understand alter based on alter's latest articulated opinion and ego's prior understanding of the whole conversation. The same holds vice versa for alter. Here,

the 'past' not only refers to distant history and to our cultural tradition but also to the beginning of that conversation). The awareness of such a hermeneutic situation is not self-evident. It requires an awareness of effective history (German *Wirkungsgeschichte*), that is the awareness of that particular relation between past and present in which past tradition is constitutive of present orientation. Understanding occurs as a hermeneutic fusion of horizons (German *Horizontverschmelzung*):

> 'a hermeneutic situation is determined by the prejudices that we bring with us. They constitute, then the horizon of a particular present, for they represent that beyond which it is impossible to see […] In fact the horizon of the present is continually in the process of being formed because we are continually having to test all our prejudices. An important part of this testing occurs in encountering the past and in understanding the tradition from which we come […] understanding is always the fusion of those horizons supposedly existing by themselves' (Gadamer 2013, p. 316 f.).

Understanding simulation validation thus requires on the part of the interpreter an awareness of the prejudice and of the tradition on which the validation concepts are based. I claim that this awareness varies with the interpreter's role and discipline.

9.4.2 Hermeneutic Naiveté Versus Hermeneutic Consciousness

Following Markus (1987, p. 9) I claim that the simulating scientist shows a hermeneutic naiveté vis-à-vis her validation concepts, methods, procedures and related practices. She is engaged with the validation of her model. However, she lacks the hermeneutic 'self-consciousness' (Markus 1987, p. 9) that is typical of many social scientists. As Markus would put it, simulation validation works on the basis of an ideology 'which regards any acceptable scientific text as totally self-sufficient as to its meaning' (Markus 1987, p. 9).

However, the hermeneutic naiveté of the simulation scientist is overcome in interdisciplinary dialogue. Two other groups of researchers who may be interested in simulation validation share this hermeneutic consciousness: philosophers of science engaging in comparative research on simulation validation, and methodologists conducting research on their respective disciplines' methods. Philosophers of science and methodologists are those researchers who have to develop the hermeneutic consciousness as part of their professional engagement with science.

9.4.3 Interdisciplinary Dialogue

Interdisciplinary dialogue constitutes a situation in which a hermeneutic situation is set up. Here, the simulation scientist loses her hermeneutic naiveté vis-à-vis her validation concepts. She perceives validation concepts different from her discipline's

tradition, which makes her increasingly aware of the historical situatedness of her own validation concepts.

Three approaches may be followed in empirical interdisciplinary dialogues in general, and apply interdisciplinary exchange about simulation validation more specifically: (1) Initially, interdisciplinary dialogue often amounts to the projection of one's self onto the other. In this case, validation concepts of one's own discipline are projected onto the other discipline. Whatever this approach yields, it is not interdisciplinary understanding. (2) Others emphasize disciplinary alterity, trying to resist the impulse to subsume other disciplines under their methodological tradition. During the dialogue, they correct their view of other disciplines. Even if this approach is intended as a guide to the beginning of the conversation between disciplines, it falls short of interdisciplinary understanding in a philosophical sense. (3) The third approach consists in comparing specific concepts, e.g. validity concepts, across disciplines. This approach focuses on specific items which bear both similarities and differences to a researcher's discipline. For instance, the concept of validity has a range of meanings in physics, and the question then becomes how it is used in another discipline.

Versions of these approaches to interdisciplinary dialogue exist in simulation validation, but hermeneutics has another perspective. Hermeneutic understanding requires us to look at our prejudice and uncover the misunderstandings that we bring with us. Understanding involves as much an engagement with one's own discipline and the situatedness of its validation concepts as it is about that discipline which is being understood.

In an interdisciplinary dialogue, hermeneutics can be understood in at least two ways: (1) as a means for understanding elements of another discipline's simulation validation concepts, in order to uncover its standing in relation to that discipline's tradition and (2) as a means for understanding elements of a discipline's own simulation validation concepts, in order to uncover its own standing in relation to its own tradition. Thus, the 'other' that is encountered may be another discipline's tradition or it may be one's own discipline's tradition or history.

Philosophical hermeneutics allows a self-critical and self-constitutive encounter with alterity as embedded in validity concepts in diverse academic disciplines. There cannot be a universal understanding because all understanding depends on prejudice and tradition. The hermeneutic perspective preserves pluralism in simulation validation: it helps establish the awareness that there is (1) no universal strategy for validation and (2) no single interpretation of a specific tradition of validation. Understanding simulation validation occurs as a hermeneutic 'fusion of horizons' in which the interpreter's horizon is enlarged and enriched. Hermeneutics' perspective is opposed to those perspectives that seek universally shared scientific values in simulation validation.

Considering the relevance of tacit knowledge (see Markus above), I claim that an adequate understanding of simulation validation texts cannot be acquired in an intercourse with the text alone. I therefore propose a more sociological reading of interdisciplinary dialogue that makes accessible the tacit knowledge. Rather than

in philosophical dialogue, a social encounter will disclose the tacit knowledge and promote our understanding of simulation validation.

9.4.4 The Hermeneutic Tasks

Hermeneutic aims in interdisciplinary dialogue are showing how simulation validation is historically situated, revealing the hidden prejudice in validating and distinguishing between legitimate prejudice and prejudice that has to be overcome.

9.4.4.1 The Historical Task

The first hermeneutic aim in theorizing simulation validation is to show how simulation validation is historically situated. At present, there is no one unique definition of simulation validation. However, Schlesinger (1979) definition of simulation validation serves as a major reference for many simulating scientists who discuss the question of how to define simulation validation. I will use their definition to illustrate the task. In Schlesinger et al.'s definition, the computerized model, the domain of applicability, the intended application of the model and the scientific value they refer to—accuracy—are historically situated. I concentrate on the most obvious aspect here: why do they refer to accuracy? Compare Schlesinger et al.'s definition to that by Caldwell and Morrison ('Validation is a proactive, diagnostic effort to ensure that the model's results are reasonable and credible' and 'to assess whether the model's outputs are reasonable for their intended purposes', Caldwell and Morrison 2000, pp. 202 f.). The relevance of the scientific value of accuracy is historically contingent. The relevance of scientific values is also situated and may depend on the discipline. The task is to show how the computerized model, the domain of applicability, the intended application of the model and the scientific values are historically situated. Without going into too much detail here, we may anticipate that an interpreter will understand the use of the concept of accuracy after it has been revealed that Schlesinger et al.'s background is in engineering and the natural sciences, where the present state of the art allows for quantitative evaluations of validity. It can be understood, then, that they somehow forgot other disciplines in which the state of the art does not allow for the meaningful use of measures of accuracy. Economists Caldwell and Morrison, instead, face a state of their art in which only qualitative evaluations of the validity of their microsimulation model can be given. In particular, there are no true experimental data against which to validate the predictions of their simulation model. It can be understood, then, that in their definition they refer to more open concepts, such as reasonableness and credibility.

9.4.4.2 The Epistemological Tasks

Gadamer's formulation of the hermeneutic circle (Gadamer 2013, p. 279) claims that the foreknowledge of an interpreter creates expectations in regard to a certain interpretation. In the hermeneutic situation, prejudice (prejudgements) undeniably structure the human understanding of the self and the world. The foreknowledge is the condition of the possibility of understanding. Gadamer rejects the negative connotation of prejudice, which he views as a prejudice of the Enlightenment (Gadamer 2013, p. 283). The epistemological task in the hermeneutics *of* validation is thus to reveal the hidden prejudice in validating. As Gadamer (2013, p. 310) has argued, this is a question for effective history (*Wirkungsgeschichte*)—that particular relation between past and present in which past tradition is constitutive of present orientation. The fundamental epistemological task is to distinguish between legitimate prejudice and prejudice that has to be overcome. Gadamer rehabilitates authority and tradition because they can be a source of legitimate prejudice (which has led his critics to argue that he is a conservative).

The foreknowledge of simulation validation includes diverse kinds of foreknowledge and prejudice: in particular, foreknowledge of the theoretical concepts of the phenomenon that is modelled, foreknowledge of the implemented theory and hypotheses, foreknowledge of the validation methods and techniques applied, foreknowledge of the domain of applicability, foreknowledge of the intended application of the model and foreknowledge of scientific values that are considered relevant, e.g. the value of accuracy.

A short illustrative example comes from climate science. As Rood explains (in Chap. 30 in this volume), 'an influential paper' by Oreskes, Shrader-Frechette, and Belitz (1994) established the formal argument that, in general, numerical models of geophysical phenomena cannot be validated. He summarizes that the argument was twofold. (1) 'The climate' cannot be observed in its entirety and (2) models are non-unique estimates of possible climate states. As Rood notes, 'the echoing of the statement that weather and climate models 'cannot be validated' does not serve the discipline well'. According to Rood, it has also contributed to a stable foundation of political argumentation that model-based predictions are too uncertain on which to base policy.

Let C-Not denote the claim that weather and climate models cannot be validated. From our hermeneutic perspective, claim C-Not shall be a starting point for a hermeneutic analysis. C-Not will be considered as foreknowledge, it has served as a prejudice in climate simulation validation. The hermeneutic analysis would have to reconstruct in detail how, on the one hand, C-Not led to great caution among climate scientists—who tended to distrust the term 'validation' and prefer to use expressions such as 'evaluation' (see Flato et al. 2013, as well as the study by Guillemont, 2010); on the other hand, the hermeneutic analysis would have to reveal how tremendous efforts in testing and validation (see the chapter by Rood) were forced by C-Not. Rood states that a 'culture of verification and validation' has been developed by climate scientists and software engineers. Empirical studies have identified different 'epistemic lifestyles' (Shackley 2001) that include verification and validation. We

will finally not only understand the present orientation in climate science simulation evaluation, but also question claim C-Not. Some of the arguments that were used to support C-Not may be revealed as prejudice that can be overcome. Finally, even C-Not may be overcome.

I have also used this short illustrative example to indicate that Gadamer's concept of effective history (*Wirkungsgeschichte*) need not refer to the distant past. It may also apply to significant events of past decades.

9.4.4.3 The Hermeneutic Tasks of Three Groups of Interpreters

Philosophers of science, and—to a lesser degree—methodologists of their disciplines, can be expected to deal with the historical and epistemological hermeneutic tasks. However, working scientists are needed, not only to explore the tacit knowledge but also to interpret and change validation practices in the light of the new insights obtained. Philosophers of science and methodologists open up the validation tradition or traditions vis-à-vis the simulating scientists and support the establishment of a hermeneutic 'self-consciousness' among the practitioners. In this way, the hermeneutics *of* validation addresses the first-order art and second-order theory.

9.5 Discussion

What are the limitations to a hermeneutics *of* validation based on Gadamer's philosophical hermeneutics? These limitations become visible if we apply the criticism of Gadamer's approach with representatives of other philosophical perspectives.

Some limitations follow from the Gadamer–Habermas debate on the issues of rational reflection and material reality (for a recent review on that debate and its outcomes see Smith 2014). Habermas argued that Gadamer's hermeneutics leaves no room for genuinely rational reflection, since it is constitutively blind to potential sources of domination. These sources are embedded in hermeneutic reflection: tradition, authority and prejudice. As a consequence, argues Habermas, hermeneutic reflection must fall short as a model of critical reflection. Tradition, authority and prejudice are accountable to standards that lie beyond them—to rational standards. Some results of that debate demarcate limitations of the hermeneutics *of* validation, in particular for interdisciplinary dialogue. There is a tension between rational reflection and understanding, and this tension is important for the growth of knowledge, in particular for the role of traditions in that area. As Gadamer (1990) has pointed out, hermeneutic reflection at its best has a self-transformative character. Traditions advance through self-correction. Ultimately, hermeneutic reflection rests on practical insight. I contend that disciplinary traditions are challenged less by a Gadamerian dialogue than by a Habermasian discourse. Habermas (1984, 1996) discourse model establishes a stringent set of rules known as ideal speech situation to support the deliberation on, and the analysis and justification of, validity claims. Communica-

tive rationality is more confrontative towards traditions, enhancing the growth of knowledge in simulation validation.

Markus' claim (1987, see above) that terminology and methods in the sciences are subject to an accelerated rate of obsolescence, rendering the use of Gadamer's concept of tradition shallow, raises the question as to whether there are traditions in simulation validation at all. This volume demonstrates that such traditions exist, providing the opportunity for further studies to reconstruct and describe them in more detail. From psychology (see e.g. Newton and Shaw 2014), we know thorough investigations into a discipline's validation traditions.

What is the significance of the hermeneutics of simulation validation with respect to the further development of computer simulation? The question of validation is an urgent one since computer simulations are developed in more and more disciplines. The hermeneutic perspective is oriented towards past and *present*. Interdisciplinary dialogue can advance the spread of validation methods and techniques across disciplines. It is no coincidence that the author of this chapter—a simulating sociologist—who is also one of two editors of this *Volume* wanted to edit this compendium. This *Volume* is a major step towards an interdisciplinary dialogue on simulation validation. Interdisciplinary dialogue may be evaluated as suitable for the late adopters, but not for the leading disciplines such as meteorology and climate science. However, these latter disciplines also profit from encountering their past.

9.6 Conclusions

In this chapter, a hermeneutics *in* simulation validation has been shown to be rather fruitless. Instead, I have proposed a hermeneutics *of* simulation validation based on Gadamer's philosophical hermeneutics.

The goal of a hermeneutics *of* validation is to understand simulation validation. Its contribution to the validation of computer simulation models is on two levels: first-order art and second-order theory. The challenge that has to be mastered is to set up a hermeneutic situation in the first place. As Ramberg and Gjesdal (2005) emphasize, appreciating hermeneutics is fundamentally a matter of perceiving a moving horizon, engaging a strand of dialogue. This *Volume* establishes such a hermeneutic situation.

Finally, I want to suggest one issue for the interdisciplinary dialogue. We should understand the preference for particular scientific values in different validation simulation traditions. As is shown by Schlesinger's definition, accuracy is presently the dominating scientific value in simulation validation. However, there is also, for instance, the value of comprehensiveness (see Chap. 40 by Hirsch Hadorn and Baumberger in this volume), apparently most often inferior. Let us discover and test our prejudice concerning accuracy and comprehensiveness and encounter the past and understand the validation traditions from which we come. Doing so will allow us to expand and enrich our horizons in relation to the prioritization of scientific values in simulation validation.

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