MODELS *and* SIMULATIONS 8 ABSTRACTS

PLENARY 1: Mieke Boon – "Scientific Models in the Engineering Sciences"
Thursday, March 15th, 9:30-10:30

On the term engineering sciences, readers may have different understandings. Commonly, emphasis on the engineering part of the term. In this paper, focus will be on the science part – that is, on research practices that perform scientific research in the context of technological applications. The engineering sciences as scientific fields in many respects resemble other natural sciences, but are also very different in a number of ways. The similarity consists in aiming to scientifically understand phenomena, which involves scientific modelling in connection with the investigation of the phenomena in experiments and computer simulations. A salient difference, however, is that the epistemic aim of investigating phenomena is not firstly scientific theories, but rather knowledge for how a phenomenon is created, controlled, manipulated, prevented or optimized through natural or physico-technological circumstances. Scientific models of phenomena, therefore, must enable and guide model-users in their reasoning about the phenomenon, which is why Knuuttila and I have emphasized the notion of scientific models as epistemic tools. This paper aims at an overview of various aspects of scientific models that typically emerge in this context, for which examples of scientific models in chemical engineering and materials science will be given. The line of reasoning will be to first point out how concepts of (natural or physico-technological) phenomena are related to design-concepts. Next, epistemic practices of modelling phenomena (in view of technological applications) will be analyzed in terms of their apparent ontological and epistemological presuppositions. Finally, it will be argued that all this can be summarized in terms of a methodology (i.e., a schema) for the analysis and construction of scientific models in the engineering sciences.

PLENARY 2: Michael Weisberg – "Confirmation Theory for Idealized Models"
Friday, March 16th, 9:00-10:00

PLENARY 3: Michela Massimi – "What Scientific Models Are for"
Friday, March 16th, 17:45-18:45
Scientific models have long been known to involve abstractions and idealisations, and not to offer necessarily veridical or accurate representations of the target system. Much has been written on models' idealizations and two main trends have clearly emerged. Some philosophers of science have taken the highly abstract and idealized nature of scientific modelling as the sign that all models are fictional—or better, that any scientific model (no matter whether its target system is real, hypothetical, or simply false) engages in a fictional make-believe game. Other philosophers have taken the highly abstract and idealized nature of scientific modelling as a springboard for re-evaluating the explanatory importance of falsehoods in science (and, occasionally, for rethinking the aim of science in terms of non-factive understanding for example). My main task is to offer a third way of thinking about scientific modelling, going beyond the dichotomy fictionalism or felicitous falsehoods. I suggest thinking of what goes on in scientific modelling along the lines of some kind of physically conceivability. I clarify what the notion of physical conceivability involves and shed light on how—embedded into different kinds of models—it can deliver important modal knowledge about what might be the case.

PLENARY 4: Peter Mättig – "The Role and Dynamics in Models Particle Physics"
Saturday, March 17th, 9:00-10:00

Today's particle physics is described by the so-called Standard 'Model' (SM) to an amazing precision. Still there is an overwhelming consensus among physicists that the SM must be seen as part of a more encompassing theory at higher energies leading to new phenomena. A plethora of beyond the SM (BSM) models has been devised predicting special signatures to be observed. In spite of intense experimental work, searches for these were as yet futile. The talk will discuss the role of models in the actual research, analysing differences between experimentalists and theorists. Furthermore we will consider if traditional and new epistemic and pragmatic values of theory choice also play a role for model preferences. These issues will be related to model dynamics, i.e. how they are affected by measurement. In particular it is discussed, how results like the Higgs discovery and the non – observation of BSM effects change the status of models in particle physics. These results lead both experimentalists and theorists to move in the direction of model – independent studies. In case of experiments the increasing importance of data driven classifications of the measurements will be illuminated.

SESSION ABSTRACTS

Thursday, March 15th 11:00-13:00

1. **SYMPOSIUM: SCALE MODELS *in* ENGINEERING**

Symposium Abstract: Scale models constitute an understudied category of models in current debates in philosophy of science, which rather focus on mathematical or computational models. The aim of this symposium is to re-evaluate the epistemic functions of scale models with a specific focus on the practice of modelling in engineering. Specific topics to be dealt with are: the notion of design within the context of engineering and in relation to the epistemic value of scale models; the nature of the targets of scale models; and the role of similarity in the construction and evaluation of scale models.

16a	Sterrett	Scale models, invariants, and similarity

Histories of scale modeling contain episodes in which success is suddenly achieved, after many failed attempts (Sterrett 2005; Sterrett 2017a). Yet, these abrupt advances are not a matter of chance, but arise when a practitioner understands the notion of invariance relevant to the phenomenon being modeled. That's the key to successful scale models, and accounts for why unsuccessful ones were unsuccessful. While the relevant notions of invariance in different disciplines (e.g., Structural Mechanics, Hydrodynamics, and Geology) arose at different times, there was also, in parallel, the development of more general approaches to similarity methods in physics. Many of the physicists who wrote about similarity are familiar historical figures: besides Newton and Galileo, there are well-known physicists of the nineteenth century: Stokes, Helmholtz, Rayleigh, and Lorentz, for instance. This intellectual effort in physics culminated in the notion of *physically similar systems* published in *The Physical Review* in 1914, in a paper by the physicist Edgar Buckingham. Unlike many others, Buckingham did not rely upon having the actual equations governing the phenomenon of interest; instead he used dimensional equations, providing a formulation that shows the considerable power of physically similar systems. Developing a point made in (Sterrett 2009 and Sterrett 2017b) I will explain the basis, founded in the logic of mature quantitative sciences, for similarity between a scale model and what it

models. In doing so, I aim to show that both Weisberg's and Pincock's accounts make similarity methods in engineering seem much less well-founded in physics than they actually are.		
16b	Pincock	Concrete scale models and essential idealization
A scientific model is essentially idealized when the model must be specified using a false statement in order for the model to fulfill its intended purpose. This paper argues for the prevalence of essentially idealized concrete models, with special emphasis on scale models that are built at a smaller or larger spatial scale than their intended target systems. These models range from traditional models of ships or airplane wings to more elaborate models of complex systems such as the San Francisco Bay. In all such cases, essential idealizations enter in when the model is used to predict or explain features of the intended target. One source of these distortions is the nature of the materials involved, as when scale effects of water are relevant to the phenomenon being modeled. This paper concludes by considering some of the means that scientists and engineers employ to cope with their idealized models, especially when their aim is to obtain accurate predictions through an examination of their model.		
16c	Sánchez-Dorado	Not only size matters. Scale models and judgments of similarity
The aim of this paper is twofold. First, I argue that an approach in iHPS (integrated History and Philosophy of Science), which looks into historical episodes in science and engineering, can be particularly insightful for the debate about the epistemic value of scale models (Sterrett 2017; Weisberg 2013). I use the documented history of the foundation of the Waterways Experimental Station in the U.S. (WES) as a case in point. Before, and still after, the foundation of the WES in 1929, there were fruitful disagreements within the U.S. Army Corps of Engineers about the kind of the knowledge that scale models could provide in comparison with numerical – and later on, computational – models (Robinson 1992). Second, I argue that the notion of "judgments of similarity" can be particularly helpful to analyse the epistemic value of scale models. Using historical reports of the construction of the Mississippi Basin Model (1943-1970s) and the San Francisco Bay Model (1953-1970s), I show how, in the practice of scale modelling, engineers made constant judgments about the similarity relation between the models under construction and the phenomena represented (U.S. Army Corps 1963; Foster 1971; Weisberg 2013). Some of these judgments of similarity concerned the application of standardized methods of physically similar systems, some others the visual qualities of the models, and some others the role of distortions and idealizations in the epistemic success of the practice of scale modelling.		
16d	Poznic	Architectural Modeling: Interplay of Designing and Representing
This paper discusses architectural models, whose use is connected to two goals at least: designing and representing. These two goals can be accounted for with two different modeling relations between vehicles and targets. In the instance of designing the target is adjusted to the vehicle and in the instance of representing the vehicle is adjusted to the target of modeling. In previous research I showed that models in bioengineering involve both of these modeling relations and that these models can be accounted for with an indirect view of representation (cf. Poznic 2016). In debates about models and representation in science, indirect views of representation are prominently discussed (Giere 1988; Godfrey-Smith 2006; Weisberg 2007; Frigg 2010). The question is whether these debates can be connected to architectural models and whether these models represent in the same way as scientific models. The answer of this paper is, in one way, architectural model represent in the fashion of scientific models. Namely by being indirectly related to their targets. In another way, architectural models function differently than		

scientific models because architectural models are not used to study natural phenomena but rather to design buildings. This paper proposes to conceptualize the relation between model and building as a bipartite relation: first, the model stands in a relation of representation to a plan of the building. In this sense the model represents something, namely a plan of the building. Second, the plan and the building are standing to each other in a relation of designing. So the intuition that the model represents something can be retained. Yet, the target of the representation relation is not the building but the plan of the building.

2. OPACITY *and* EPISTEMOLOGY *of* SIMULATIONS

<table>
<tr><td>32</td><td>Humphreys</td><td>Reducing Representational Opacity</td></tr>
<tr><td colspan="3">This paper explores the role of representations in computational processes applied to large data sets that use machine learning methods for pattern recognition. It uses the distinction between transparent and opaque representations to argue that apparently opaque representations are common in particular types of deep neural nets. Although such opaque computational representations seem to require reliabilist accounts of the knowledge produced by those computational models, it is possible in some cases to transform opaque representations into transparent compositional representations. I conclude by considering some difficulties associated with the interpretation of these transformed representations.</td></tr>
<tr><td>28</td><td>Formanek</td><td>Modal troubles with epistemic opacity</td></tr>
<tr><td colspan="3">Epistemic opacity is defined in terms of knowledge and modality. I will make this definition more explicit by employing the JTB-account of knowledge. I then argue that the focus of analysis should lie on the justificatory condition. Furthermore, the modal limits imposed on justification, namely human or in-practice modality are shown to be restrictive and I argue that on the standard reading justification rather requires in-principle or logical modality. I conclude by outlining a theory of justification (reliablism) for computer simulations which while retaining human commitment is not dependent on human modality.</td></tr>
<tr><td>60</td><td>Creel</td><td>Transparency in Complex Computational Systems</td></tr>
<tr><td colspan="3">Scientists depend on complex computational models that are often ineliminably opaque, to the detriment of our ability to give scientific explanations and detect artifacts. Some philosophers have suggested treating opaque models instrumentally, but the computer scientists developing new strategies for increasing transparency are right not to find this satisfying. Instead, I propose an analysis of transparency as having three forms: transparency of the algorithm, the way that algorithm is written in code, and the way that code is run on particular hardware and data. This allows us to target the kind of transparency most useful for a given task.</td></tr>
<tr><td>17</td><td>Lehtinen</td><td>Testing the tools; Computer simulations in the design of research methods</td></tr>
<tr><td colspan="3">This paper discusses a particular way in which computer simulations are used to test the performance of their research tools. Statisticians employ (usually some version of Monte Carlo) simulation to compare the performance of several estimators at the same time in an artificial simulated environment, testing which estimator is the best at capturing the ‘truth’ under various different configurations of causal influences. The epistemic credibility of this method is based on being able to know how the possible causal influences would affect the data, if they were operative.</td></tr>
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Thursday, March 15th 14:00-16:00

3. MODELS *in* ECONOMICS

73	Knuuttila and Morgan	Simple - And Thick: Abstract Models in Economics
We argue that the conventional philosophical notion of abstraction as omission does not do justice to the constitution of abstract models, and their construction processes. Apart from omitting known details, modelers also bring in various kinds of ingredients to their models, and as a result abstract models are thick in theoretical, conceptual, empirical, and formal content. We analyse this thickness of abstract models through some examples from economics, although our analysis applies also to models in other disciplines		
58	Sperry	Complexity Economics: When Equilibrium Explanations Fail
Equilibrium explanations are highly abstract explanations of dynamic systems through an equilibrium state. Said explanations remove all causal information to reveal a system's deeper, underlying structure, which ought to increase our understanding. Indeed, economists rely on equilibrium explanations to understand why an asset's price converges towards equilibrium as supply matches demand. Yet there is mounting empirical evidence that non-equilibrium dynamics are prevalent, and that equilibrium explanations have little application to real markets. I introduce computational methods to study specific causal mechanisms behind equilibrium behavior. I conclude that causal information increases our understanding of markets beyond equilibrium explanations.		
3	Nebel	A Puzzle about Economic Explanation
Economists use two different models to explain why it is that firms are capable of pricing above marginal cost, the Cournot and Bertrand duopoly models. They accept both models as good explanations of the phenomenon, but the two models contradict themselves in various important ways. This paper presents the puzzle and then offers five possible solutions to that puzzle from various philosophers of science and philosophers of economics.		
55	Jhun	Modelling Complex Phenomena: Econometrics as a Case Study
A careful investigation of history and practice reveals that econometric models are often not meant to be, strictly speaking, representational. Yet, they are expected to yield causal understanding by identifying the mechanisms underlying economic behavior. This may seem paradoxical; I argue that we can discharge these difficulties by paying attention to how econometricians incorporate method into their models. These observations will have implications more generally for modeling complex phenomena, in particular more recent developments in multi-scale modeling.		

4. MODELS *in* PHYSICS

20	Jacquart	Observing the Invisible: Dark Matter & Computer Simulations
Our collaboration between astronomers and philosophers attempts to search for the universe's missing dark matter, investigating the hypothesis that some of it resides in dark matter galaxies. In this talk, I address questions related to epistemic warrant: how do astrophysicists blend observation, simulation, and theorizing to warrant inferences about such objects? I focus on the role computer simulations play in astrophysical inferences to provide an argument for how chains of epistemic warrant work and contribute evidence in our dark galaxy hunt. This case provides insight into understanding how computer simulations of complex phenomena add to		

observations themselves, and justify conclusions about the nature and behavior of the objects in theories.		
52	Elder	LIGO and Models as Mediators
On September 14, 2015 the LIGO observatories detected gravitational waves for the first time. For a confirmed detection, a signal has to be extracted from raw data and matched to a model-generated waveform representing a particular merger. Based on this match, it is concluded that a binary black hole (BBH) merger occurred, and inferences are made about various properties of the black holes involved. In this paper I will investigate the recently developed techniques in numerical relativity used to model BBHs for LIGO, drawing lessons about the relationship between theory, model, and data in the LIGO detection runs.		
38	Chall	Particle Physics Model-Groups as Scientific Research Programmes
The framework of Lakatosian research programmes, modified to accommodate the model-groups of particle physics, explains the model dynamics within the search for physics beyond the standard model in the Higgs sector. At the moment, there is no evidence for BSM physics, despite a concerted search effort. The notion of scientific research programmes explains the way aspects of the periphery of a model-group change as the available parameter space shrinks, while the hard core remains unaltered. I will use the Composite Higgs model-group as a case study for the adoption of this Lakatosian idea to particle physics.		
34	Pronskikh	Simulation study of epistemic democracy in big science
Division of labor in Big Science (for example, high-energy physics) has resulted in the emergence of separate discursive communities of instrument makers, experimentalists, and theorists that have developed separate discourses and epistemic strategies. Stratification of the communities in the context of theory-laden high-energy physics experiments has resulted in establishment of their epistemic hierarchy and subordination of epistemically disadvantaged communities to more epistemically privileged ones. In this work, drawing on the concept of epistemic democracy, I use simulations to argue that epistemic equality, which enables us to overcome the epistemic disunity in high-energy physics experiments, is beneficial for Big Science.		

5. EPISTEMOLOGY *and* MODELS

51	Bursten	Against the Hierarchical View of Theories
I articulate a widely-held view about inter-theory relations, which I call the hierarchical view of theories. I argue that this view is shared by reductionism and emergence, and that the hierarchical view impoverishes philosophical accounts of inter-theory relations. By focusing too narrowly on the explanatory and predictive work accomplished at individual or component levels, the hierarchical view excludes the epistemic contributions of the conceptual strategies employed to connect higher-level theories to lower-level ones. These strategies are an essential and as-yet ill-understood piece of architecture in the epistemology of science, and the hierarchical view has occluded them from analysis.		
39	Verreault-Julien	Learning and understanding with models: same same but different?

<table>
<tr><td colspan="3">How to assess the epistemic contribution of idealized models is an enduring problem. Two proposals have been made: 1) we may learn from models (e.g. Grüne-Yanoff 2009) and 2) models may afford understanding (e.g. Kuorikoski and Ylikoski 2015). However, it is unclear whether learning and understanding are similar or whether they are, in fact, two different sorts of epistemic benefits. Using a distinction between reductionist and non-reductionist accounts of understanding (see Sullivan 2017), I show under what conditions learning and understanding may be similar or may differ. This in turn opens new avenues of research.</td></tr>
<tr><td>76</td><td>Henne</td><td>Denorming Causation: the model-based theory of causation and norms</td></tr>
<tr><td colspan="3">Work on causal reasoning (Hitchcock and Knobe, 2009) and omissive causal reasoning (Henne, Pinillos, & De Brigard, 2017) shows that norms bias causal judgments such that abnormal events and omissions are more likely to be judged as causes relative to normal events and omissions. Another proposal is that reasoners represent possibilities that are consistent with comissive (Johnson-Laird & Khemlani, 2017) and omissive causation (Bello & Khemlani, 2015) and their related semantic terms. In four experiments, I show that norm bias causal judgments when reasoners have access to fewer possibilities but also that when they have access to fully explicit representations of causing or allowing model, norms do not significantly bias judgments.</td></tr>
<tr><td>48</td><td>Neuman and Danka</td><td>The intimate relationship between thought experiments and simulations - do they provide fresh knowledge about Nature?</td></tr>
<tr><td colspan="3">We construe the epistemological status of scientific thought experiments. We will show that it is not impossible for a scientific thought experiment to generate new knowledge, not possible to derive form the theory using logical methods. We present a certain type of computer simulation used by physicists as counter-example against the claim that thought experiments do not provide genuine, fresh knowledge about Nature. The assessment is based on Kant’s view about the existence of predicates providing new knowledge, that are not empirical.</td></tr>
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Thursday, March 15th 16:30-18:30

6. MODELS *in* CHEMISTRY *and* BIOLOGY

<table>
<tr><td>15</td><td>Price</td><td>The Landing Zone - Preparing Ground for Model Transfer in Chemistry</td></tr>
<tr><td colspan="3">I propose a new notion – the landing zone – in order to identify conceptual features that allow modelers to transfer mathematical tools across disciplinary boarders. Philosophical discussion identifies the transferable models as containing templates - functions, equations, or computational methods that are capable of being generalized from a particular subject matter. I argue that there are formal and conceptual conditions for their transfer. My paper presents a case study on a model in chemistry The Quantum Theory of Atoms in Molecules (QTAIM). I also argue a complete account of QTAIM's transfer of templates from physics requires this additional notion, landing zones.</td></tr>
<tr><td>47</td><td>Bolinska and Gandier</td><td>Understanding protein function through multiple models of structure: barriers to integration</td></tr>
<tr><td colspan="3">In order to understand protein function, information from models of structure generated from different experimental techniques must often be integrated. We show that such integration sometimes takes the form of the undue influence of models of structure produced using one</td></tr>
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experimental technique on the interpretation of data from another. We argue that interpretation of data should instead take place with close attention to the experimental context in which it was generated, resulting in models that best exhibit features of the protein which that context is designed to showcase. Integration should take place only thereafter and should take the form of "integration that maintains pluralism" (Mitchell & Gronenborn 2015): information from each model should be integrated to inform understandings of protein function, while nonetheless retaining each model.		
22	Bokulich	Using Models to Correct Data: Paleodiversity and the Fossil Record
Despite an enormous philosophical literature on models in science, surprisingly little has been written about data models and how they are constructed. In this paper, I examine the case of how paleodiversity data models are constructed from the fossil data. In particular, I show how paleontologists are using various model-based techniques to correct the data. Drawing on this research, I argue for the following related theses: First, the 'purity' of a data model is not a measure of its epistemic reliability. Instead it is the fidelity of the data that matters. Second, the fidelity of a data model in capturing the signal of interest is a matter of degree. Third, the fidelity of a data model can be improved 'vicariously', such as through the use of post hoc model-based correction techniques. And, fourth, data models, like theoretical models, should be assessed as adequate (or inadequate) for particular purposes.		
42	Parkkinen	Are model organisms like theoretical models?
Levy and Currie (2015) have recently argued against the view that theoretical models and model organisms are both forms of indirect representation by pointing out a difference in the justification of model-to-target inferences: model-target analogy in the former, empirical extrapolation in the latter. I argue that Levy and Currie's point about model organisms not being representations is true, but drawing the distinction with respect to justification strategies fails. Instead, I argue that the difference lies in whether the model is used as an inferential aid, or as a surrogate source of evidence.		

7. MODELS *in* POLICY

44	Cuffaro and Kao	Employing Agent-Based Computer Simulations in Developing Theories of Distributive Justice
Rawls's `difference principle' (DP) is a principle for distributive justice which forms part of the backbone of his conception of societal-level justice: Justice As Fairness. DP directs one to maximise the well-being of the least well-off, and Rawls argues that it would be chosen by parties deliberating to decide on a social contract. Restricted Utilitarianism replaces DP with the `social minimum principle' (SP): which directs one to maximise average well-being but establishes a fixed minimum below which no member of society may fall. Using agent-based computational modelling, we examine arguments in the debate between defenders of JF and RU.		
36	MacLeod and Nagatsu	What does interdisciplinarity look like in practice: Mapping interdisciplinary modeling and its limits in the environmental sciences
In this paper we take a close look at current interdisciplinary modeling practices in the environmental sciences, and argue for much closer attention to be paid to the nature of scientific practices when investigating and planning interdisciplinarity. While interdisciplinarity is often portrayed as medium of novel and transformative methodological work, current modeling		

strategies in the environmental sciences are conservative, avoiding methodological conflict, while confining interdisciplinary interactions to a relatively small set of pre-existing modeling frameworks and strategies (a process we call crystallization). We argue that such practices can be rationalized as responses in part to cognitive constraints which restrict interdisciplinary work. The impact of such constraints on interdisciplinary practices are not yet so well understood. Further the crystallization of interdisciplinary modeling practices around a relatively finite set of frameworks and strategies, while contradicting somewhat the novelty goals many have for interdisciplinarity, makes sense when considered in the light of common disciplinary practices. These results provide cause to rethink in more concrete methodological terms what interdisciplinarity amounts to, and what kinds of interdisciplinarity are obtainable in the environmental sciences and elsewhere.

Friday, March 16th 10:30-12:30

8. SYMPOSIUM: MODELS *and* SIMULATIONS *in* SYSTEMATICS

Symposium Abstract: We analyze the roles of theoretical and empirical assumptions in models in systematics. We present an integrated historical philosophical analysis of a family of pre-Darwinian models of the natural system of relationships between organisms and species. We then analyze the role of evolutionary models in phylogenetic inference to make claims about the branching pattern of descent between species. Finally we analyze the problem of ignoring model assumptions in the case of current application of the multispecies coalescent model to species delimitation.		
7a	Quinn	Models and Simulations in Systematics
7b	Novick	Models and Simulations in Systematics
7c	Hillis	Models and Simulations in Systematics

9. SYMPOSIUM: WHY SIMULATIONS ARE DIFFERENT

Symposium Abstract: In this symposium, we discuss the epistemic status of computer simulations (CS) to further the understanding of how CS can predict and explain the behavior of real-world systems using examples from high-energy physics. Challenging recent claims that CS and experiments are epistemically on par, we show aspects of verification and validation to bring out differences between CS and experiments. We argue that the knowledge gain that derives from CS is characterized by the uncertain inferences they promote and ask whether the focus on microlevel descriptions of CS might limit their explanatory power.		
71a	Beisbart	Computer simulation in experimentation versus computer simulation as experiment
Are computer simulations experiments? Are they at least epistemically on par with them? These questions are at the center of a lively debate in the philosophy of computer simulation. So far, the focus has been on computer simulations that are supposed to yield approximate solutions to equations from theories and that are in this sense theoretically motivated. But computer simulations play a central role within experiments too, for instance in particle physics. In a recent paper, Massimi and Bhimji have used such experiments to argue that computer simulations and experiments are epistemically on par. This aim of this talk is to discuss the view taken by Massimi and Bhimji. The main thread of my criticism can be summarized in the slogan: That computer simulation is used in experimentation (broadly conceived) doesn't show it to be experiments or on par with experiments. I start with examples of computer simulations in		

experimental high-energy physics. My aim here is to identify the key tasks that computer simulations are supposed to fulfill. I then present the view by Massimi and Bhimji and discuss it in depth. I come to reject the claim that computer simulations are on par with experiments even in experiments from high-energy physics and present the alternative view that some computer simulations model experiments. My question then is how simulated experiments can complement real experiments. In the last part of the talk I focus on validation and try to show that validation may be used to bring out differences between experimentation and computer simulation.		
71b	Boge	Computer simulations and uncertain reasoning
Computer simulations (CS) play an integral role in modern science. While it has sometimes been disputed that philosophizing about them can bring about any significant new insights – which may be correct to the extent that the epistemological issues arising in the context of CS are strongly connected to epistemological issues known from other contexts – there still remain some specific issues concerning the role and status of CS in actual research. Most importantly, views about what precisely CS are, epistemologically speaking, strongly contrast or even apparently contradict each other. In my talk, I will pursue two central aims: I will (i) consider two strongly contrasting views of simulations and demonstrate that these are ultimately complementary, not mutually exclusive, and both have their righteous place in actual scientific practice. The two contrasting views concern, in particular, the view of CS as *arguments*, developed in papers by Beisbart and Beisbart and Norton, and the view of CS as comparable to or epistemically on par with *experiments*, as defended notably by M. Morrison. I will then (ii) argue that the main 'epistemic thrust' of CS stems from the inferences they *promote*, not from the inferences that they (arguably) 'are'. These former inferences, as I will argue, constitute an instance of abductive rather than deductive reasoning, and the specific kind of abduction involved makes it understandable how CS can be both, a 'kind of experiment' and a 'kind of argument'.		
71c	Grünke	Epistemic status of simulations and the role of verification
In the recent debates about computer simulations, many claims have been made about the epistemic status of computer simulations, especially in comparison to experiments. In my talk, I start by discussing the notion of "epistemological on par". Recent papers in the debate usually claim either that this relation holds between simulation and experiment or argue against it. I take a closer look at a definition of the notion and discuss which questions have to be answered in order to give an assessment of epistemic privilege. In the second part of my talk, I focus on verification of computer simulations. Morrison and Winsberg have given recent accounts of verification that differ in some significant aspects. Using an example from high-energy physics, I will argue for a distinction between two types of simulations: theory-coherent simulations and data-orientated simulations. This distinction explains the differences in the above-mentioned accounts of verification by Winsberg and Morrison, since they were discussing different types of simulations and the relationship of the simulation to theory and data respectively affects the way the simulation can be verified. In the final part of the talk, I discuss how these different types of verification for the respective types of simulation influence the epistemic status of the simulation, concluding that theory-coherent simulations can under specific circumstances be epistemically on par with experiments and that data-orientated simulations cannot.		

10. IDEALIZATION, ABSTRACTION, *and* MODELS *of* SCIENCE

2	Shech and Gelfert	The Exploratory Role of Idealizations and Limiting Cases in Models
In this article we argue that idealizations and limiting cases in models play an exploratory role in science. Four senses of exploration are presented: exploration of the structure and representational capacities of theory; proof-of-principle demonstrations; potential explanations; and exploring the suitability of target systems. We illustrate our claims through three case studies, including the Aharonov-Bohm effect, the emergence of anyons and fractional quantum statistics, and the Hubbard model of the Mott phase transitions. We end by reflecting on how our case studies and claims compare to accounts of idealization in the philosophy of science literature such as Michael Weisberg's three-fold taxonomy.		
21	Rivat	Effective theories and infinite idealizations: A challenge for scientific realism
Despite the increasing importance of effective field theories in modern physics, the general notion of effective theory has received little attention. This is unfortunate because, as Hartmann (2001) suggests, effective theories do not seem to reduce to either phenomenological models or proviso-free theories. They even appear to offer the best of both worlds. After clarifying the minimal structure and the standard interpretation of effective theories, I argue in this talk that effective theories entail that infinite idealizations in physics are not even close to being accurate. I conclude by suggesting that this poses a serious challenge for scientific realism.		
77	Holman	It's only a model
The paper first introduces a few canonical examples of such models (Weisberg-Muldoon, Zollman, and Hong-Page). The paper looks at three classes of critiques that have been levied against formal models. I next argue that an unappreciated function of models is "intellectual exploration." Such a use moves beyond "how possible models" where the effect is known and a possible causal pathway is modeled; I argue that when modelers engage in "intellectual exploration" they are identifying completely new effects. Given this function of models, while the concern implementation remains, concerns about reliability and empirical grounding are not germane.		
74	Carrillo and Knuuttila	Macro Level Modeling of Phenomena: A Challenge to the Current Mechanist Discussion
Simplified and abstract models cannot easily be accommodated by the mechanistic account of explanation that is based on detailed description of actual mechanisms. Mechanists have argued that abstract models ought be seen as mechanism sketches, or results of aggregation or omission. We contrast the amply discussed Hodgkin and Huxley model with a recent model of the nerve impulse that cannot properly be addressed as a sketch, or as an aggregative or omissive abstraction. Our analysis of the Heimburg and Jackson model shows that macro-level models like many network models and thermodynamical models are not adequately encompassed under the mechanist umbrella.		

Friday, March 16th 13:30-15:00

11. SYMPOSIUM (AJIST): PREDICTING *the* UNEXPECTED

Symposium Abstract: Prediction is an important goal shared by many sciences. It is commonly observed that computational models and simulations foster, enlarge, or even create predictive capacities. Such capacities are of particular value when the predicted events or phenomena come as a surprise. For instance, how can scientists detect a Higgs among petabytes of data? Or how should one classify the risk of a major hurricane hitting the coast of this state? Searching for surprises – simulated surprises might be used to detect or to avoid real ones – often requires us to push models and simulations toward rare events and/or complex interactions. What are sound strategies for stretching and not over-stretching? What are the challenges these strategies have to face and master? Answering these questions is not a matter of computational power alone. Any practical case will require to taking into account modeling strategies and definitions of concepts as well as institutional organization and societal framework. In short, this is a truly interdisciplinary challenge for the studies of science and technology. This symposium will present four contributions that address the challenge from different perspectives. This symposium is sponsored by the Ann Johnson Institute for Science, Technology & Society. The Ann Johnson Institute is dedicated to building diverse communities for the study of technology, medicine and science in past and present societies. It envisions STS in partnership with historical, philosophical, scientific and engineering approaches. The activities we support are designed to contribute to building a better community because at the AJI community is the method.

11a	Weinkle	Knowledge Politics and Catastrophe Insurance

JW discusses estimates of hurricane damage and the role it plays for defining risk and assigning insurance policies. She argues that politics is an inherent part of measuring risk and applying insurance.

11b	Merz	Simulation, Images, and the Statistics of Rare Events: The Case of the Higgs Search

MM investigates how researchers at the LHC, Cern, operationalize extremely rare events in their search for the Higgs particle. Data analysis, so Merz, decisively relies on the computational and pictorial juxtaposition of "real" and "simulated data", based on multiple models of different kind.

11c	Lenhard and Hasse	A Reproducibility Crisis in Exact Sciences. Simulation and the Identity of Mathematical Models

JL analyzes recent problems in reproducing simulation results and argues that the main source of these problems is the complicated process of implementing one (and the same) model at different locations. The implementation process might seriously impinge on the identity of a simulation model.

11d	Simpson	Complexity – Tractability – Significance. Finding a Balance in Statistical Modeling

DS critically discusses the recent (M&S-based) trend in statistics to utilize computational power for creating and handling more complex models that should cover more rare and exotic cases.

12. MATHEMATICS *and* MODELS

13	Friedman and Krauthausen	Models and Mathematics at the End of the 19th Century

We propose that at the second half of the 19th century, modeling, both in pure mathematics and mathematical physics, was an activity oscillating between a mere representation and a creation and discovery of a mathematical and physical reality. This can be seen not only with the tradition of material mathematical and physical models, but also with Maxwell’s discussions on the role of the “geometric model” in the field of electricity and magnetism, as well as with Klein’s theoretic models of Riemann surfaces. Modeling was conceptualized both as an act of concretization and abstraction, prompting mathematical abstraction.

19	Danne	The Mathematical Language Needed on (but Missing from) Surface Spectral Reflectance Plots
Most of the surface spectral reflectance (SSR) plots deployed by philosophers to debate color objectivism are seriously misleading. Non-experts are unlikely to realize that SSR plots purport to denote the dispositional property of a surface to reflect incident light at some efficiency per wavelength, but that such SSR values prove operationally untenable when incident pulse durations are very short. The problem is serious because demarcating a range of durations within which SSR values obtain destroys color objectivism. I argue that appending a mathematical disclaimer to SSR plots eliminates ambiguity between dispositional ascription and operational expectation.		
50	Ishida	Equations and models
Weisberg and others argue that equations are not mathematical models; equations are like sentences describing a model. I argue that equations function as iconic representations of physical systems. In the qualitative analysis of ordinary differential equations (ODEs), scientists rely on graphical/visual techniques. Using this example and Peirce's and Haugeland's theories of representation, I explain the iconicity of ODEs and show that my account makes better sense of the importance of graphical techniques in mathematical modeling. Equations are like diagrams rather than sentences, and it is not a mistake to regard equations as models.		
70	Guralp	Using data models and simulations in testing supernova cosmology
Supernova methodology is one of the central contenders in empirical cosmology, currently aiming to measure the dark energy equation of state parameter. This measurement requires a very high precision, compelling the supernova cosmologists to seek ways to improve their current statistical methodology. In this paper, I consider two recent projects that offer new statistical techniques using Bayesian models, and show that both of them rely heavily on simulated data to justify their analytical frameworks. I argue that this introduces a critical circularity into their argument. For, as I wish to demonstrate, these data simulations are produced using the very same models that the new frameworks intend to overcome. I argue that an iterative strategy incorporating distinct data models may provide a way out of this circularity.		

13. *The* RELATIONSHIP *between* EXPLANATION *and* IDEALIZATION

8	Rice	Universality and Modeling Limiting Behaviors
Most attempts to justify the use of idealized models to explain appeal to the irrelevance of the features distorted and to the accuracy of the model with respect to difference-making (i.e. causally relevant) features for the target explanandum. In this paper, I argue for an alternative way to justify using idealized models to explain that appeals to universality classes instead of accurate representation of difference makers. In support of this alternative view, I contend that cases of modeling limiting behaviors across multiple scientific disciplines are better accommodated by the universality account.		
10	Wayne	Model-based explanation and global theory
The goal of this talk is to better understand how scientific explanation functions in the context of idealized models by exploring their connection with the larger scientific fields in which they are embedded. I contend that local models are explanatory only when appropriately related to a global theory. I develop a necessary condition that the explanation and the model must satisfy: no entities in the model that are essential to the explanation are physically impossible according		

to the relevant global theory. I apply it to explanations of gravitational waves in general relativity.		
29	Zach	Minimal models, representation, and explanation
In this paper I argue for a pluralistic conception of minimal models while putting forth several criteria that a minimal model has to satisfy. I present a sketch of a typology of minimal models. Next, I clarify the distinction between representation and successful representation which is being conflated on some accounts of minimal models. Given this distinction and that there are different types of minimal models I argue that we have good reasons to also expect a pluralistic conception of minimal model explanation. Proving a typology is thus an important step in a much needed clarification of a number of topics.		
30	Khalifa and Sullivan	Idealizations and Understanding: Much Ado about Nothing?
Many take idealizations' contributions to scientific understanding to support the claim that that some falsehoods are epistemically valuable. Against these positions, we argue that idealizations qua falsehoods only have non-epistemic value. To establish our thesis, we show that for each of the four leading proposals promoting idealizations' importance to understanding, (a) the idealizations' false components only promote psychological convenience instead of some epistemic good, such as understanding, and (b) only the idealizations' true components have epistemic value. We use models from physics and economics to illustrate our points.		

14. TOY MODELS *and* REPRESENTATION *in* SCIENTIFIC PRACTICE

41	Nguyen	It's not a game: accurate representation with toy models
\`Toy models' seem to pose a philosophical puzzle: they are ubiquitous in scientific practice, and yet they are so different from the messy systems out there in the real world that we are ultimately interested in. How are we supposed to learn anything about complex real systems by investigating incredibly simple and highly idealised models? In this paper I argue that this only appears problematic if one thinks that accurate representations have to, in some sense, resemble, or be similar to, their targets. Once this assumption is dropped, and there are good reasons to drop it, the puzzle dissolves. I argue that toy models, and idealised models more generally, can be understood as accurate representations (and by this is I do mean accurate representations, not just that they furnish us with understanding about their targets or that they explain in a way that does not require accurate representation) in much the same way as more complex models are understood as accurate representations. In doing so I argue that idealisation should not be understood as misrepresentation, just so long as the idealisations are sufficiently well behaved. I further suggest that the epistemic status of toy models is better understood in terms of a trade-off between precision and generality.		
43	Dethier	Models, Fictions, and Representing Scientific Practice
In practice, the fiction view of models has been limited to treatments of models in terms of Walton's "pretense" view of fiction. As presented, however, this view is incapable of handling certain comparisons between models and the world. Such comparisons are essential to our ability to learn from models. A technical modification of the fiction view---introducing pretense operators on the level of individual predications---resolves the issue, and has the added benefit of allaying concerns about whether models can actually have the properties ascribed them. Adopting this alternation allows the defender of the fiction view to remain agnostic about metaphysics.		

24	Boesch	Representational Licensing in Scale-Models and Ecological Graph Models: Two Case Studies
Previously, I have argued that understanding scientific representation requires understanding how representational vehicles are licensed: constructed, constrained, and utilized over time by the practice for the sake of certain representational aims. To further develop this idea, I will examine two case studies of the licensing of representational vehicles, aiming to describe the way in which the vehicles were licensed as representations of their respective targets. The case studies are of a scale model of the Mississippi River Basin and a graph model in ecology and help to reveal some of the complex features that contribute to representational licensing.		

15. MODEL EXPLANATION

53	Revlett	Demystifying ontic explanation
Wesley Salmon distinguishes epistemic and ontic explanations (1984). Recent literature on modelling in economics has used this distinction to ground a disagreement over causal realism and the role of philosophy of economics. In this paper, I will argue that epistemic and ontic explanations are more alike than different. They are both characterized by how convincing they are to some audience. The difference is the relevant audience. I will show how this reconceptualization resolves the dispute over causal realism and the role of philosophy of economics.		
68	King	Explanatory Models: A framework for instrumentalism
Philosophical accounts of explanation make a veridicality requirement on the statements featuring in explanations. However, these statements are rarely literally true of the world, and sometimes are not even approximately true of the world. What the statements are literally true of is some explanatory model. This paper presents a framework for explanation in which models are complex abstract objects and the statements that feature in explanans are literally true of those models and their possible configurations. This restricts the role of realism in explanation, but allows for an instrumentalist approach to models in explanation.		
18	Fumagalli	How 'Thin' Rational Choice Theory Explains Choices
The critics of rational choice theory (RCT) frequently build on the contrast between so-called ‘thick’ and ‘thin’ interpretations of RCT to argue that this theory lacks the potential to explain the choices of real-world agents. In this paper, I draw on often-cited RCT applications in economics and other decision sciences to demonstrate that contra this critique there are at least three different senses in which thin RCT can explain real-world agents’ choices. I then defend this thesis against the most influential objections put forward by the critics of RCT. In doing so, I explicate the implications of my thesis for the ongoing philosophical debate concerning the explanatory potential of RCT and the comparative merits of widely endorsed accounts of explanation.		
57	Muntean	Aggregating multilevel mechanistic models from Big Data with Machine Learning
This paper discusses the epistemology of building mechanistic models in data-driven and computational-intensive scientific disciplines, when the evidence used is Big Data and the computational architecture used in data mining is machine learning (ML). Is mining Big Data with ML a proper method of building mechanistic models? If so, how do ML together with Big Data qua evidence change the way we explain and predict with mechanistic models? We use three concepts: modularity, organization and feedback, and argue that they can be discovered		

through ML in Big Data and that a new type of mechanistic models can emerge from Big Data and ML processing of it. This will allow scientists to aggregate mechanisms at different levels from the deep connections discovered from Big Data. Two types of models are combined accordingly: mechanism modeling and computational modeling and can be used in multi-level modeling. Two concrete examples from biology and cognitive science are shortly discussed as illustration. Presumably, ML and Big Data would be used in the future to reveal multilevel, deep interactions and feedback loops hard (or impossible) to comprehend by the human mind. Here computational tools (ex. ML) will play a central epistemic role. The interdisciplinarity of such multilevel mechanistic models is shortly assessed.

16. HISTORY *and* PHILOSOPHY *of* COMPUTER SIMULATIONS

9	Duran	The historical and philosophical roots of computer simulations
I analyze the notion of "computer simulation" as found in the engineering and the philosophical literature from the early 1960s to the late 1990s with two purposes in mind: one historical, and one philosophical. From the historical angle, I show the development of the concept through different periods of technological development. I particularly focus on interpreting computer simulations either as problem-solving techniques or as descriptions of patterns of behaviour. The philosophical purpose aims at showing the consequences resulting from interpreting computer simulations in either way.		
35	Hladky	Simulations - Lessons from model theory
There are two ways to analyse computer simulations. Paul Humphreys proposes a complex account that aims at covering all aspects of contemporary scientific discourse. Another approach is to seek a simple theory of models and simulations and to deal with the apparent mismatches with scientific practice. I will follow the second approach, by proposing a theory based on set theory and model theory, and show that many discrepancies disappear when one distinguishes an ontological, an epistemic and a pragmatic level. I will illustrate the applicability and the advantages of my analysis with a case study from neuroscience.		
78	Livengood, Briley, and Derringer	Reflecting on Simulating Models of Development under Plausible Gene-Environment Interplay
In this paper, we use simulation work in behavioral genetics to illustrate and defend a collection of claims regarding the epistemology of simulations and the relationship between simulations and experiments. We argue that simulation studies are experiments. We argue that external validity is ultimately about similarity of causal structure: whenever two systems have sufficiently similar abstract causal structure, inferences from the behavior of one system to the behavior of the other are justified. And we argue that simulations have (at least) three distinct modes of operation: (1) for model selection; (2) for guiding new experimental research; and (3) for prediction.		
45	Haar	Discovery via computer simulation model-building
The similarities and differences between computer simulation and experiment have been debated at length with a primary question being whether through computer simulations we are able to make discoveries about the world. Common to this literature is the assumption that the computer simulation in question is fully designed or complete. However computer simulations are often used to build a model of a target system. The purpose of this paper is to examine a case of model-building from reservoir engineering to demonstrate that (1) we can learn something new about the world from computer simulations via model-building and (2) consider different		

theories of evidence on which to evaluate the justification of an existential claim through simulation modeling.

17. REPRESENTATION *and* SIMILARITY

27	Khosrowi	Getting Serious about Shared Features
Michael Weisberg offers a similarity-based account of the model-world relation, i.e. the relation in virtue of which successful models are successful. Weisberg's main idea is that models are similar to targets in virtue of sharing features. I argue that Weisberg fails to give a successful analysis of similarity because he does not offer an adequate account of shared features. I consider three construals of shared features, as identical, quantitatively sufficiently close, and sufficiently similar features, arguing that each of these construals faces significant challenges. I expand on how a pluralistic revision of Weisberg's account may help evade these challenges.		
72	Nordmann	Similarity as Evidence
This paper considers an inferential practice in contemporary technoscience which relies on the similarity between models and phenomena and among models. The practice in question takes similarity as sufficient evidence for explicability, that is, as evidence for truth of a certain kind: The similarity or visual likeness of a recorded phenomenon and its simulation signifies that the simulation explains the phenomenon. This would not appear to be a legitimate inference by the methodological canon of the philosophy of science. Its warrant turns out to be technological - it relies on the construction of a physical system that exhibits the same behavior as the target system such that both systems can be said to share the same dynamics.		
37	Greif	Images and Consequents. On Formal and Material Analogy in Computer Simulations
In light of Hesse's distinction between formal and material analogies in scientific modelling, computer simulations in science assume a twofold role. First, they typically are computational realisations of formal models of their target systems, and as such help to determine their empirical correctness. Second, simulations typically comprise an aspect of material modelling, so as to make relevant properties of the target system perceivable. It will be argued that these two aspects are only partly interdependent: As the formal model bears the primary responsibility for representing the target system, and as both the computational core and the empirical rendering of the simulation are underdetermined by that formal model, the matching between these formal and material aspects follows pragmatic criteria.		

18. MODELS *in* CLIMATE SCIENCE

25	Roussos	Against model aggregation
In the sciences of climate change and hurricane prediction, the outputs of disagreeing models are combined in a linear average, weighted according to a skill score. I argue against this practice. I show it cannot be justified by the popular analogy with statistical sampling. I then present four reasons additional not to aggregate: (1) it discards decision-relevant information, (2) it obscures model uncertainty, (3) it presents a misleading aura of "objectivity", and (4) averaging is non-ideal and conflicts with Bayesianism. Some of these problems can be mitigated, others establish a prima facia case against aggregation, in these sciences.		
62	Pruss	A defense of historical proxy models in climate science
The use of climate simulations for theory confirmation has been the basis of much discussion among philosophers of science, but to date, little attention has been given to historical proxy models. In this paper, I defend the use of historical proxies. I argue that the sparseness and		

uncertainty of proxy models is tempered using robust sets of data; that rejecting the auxiliary assumptions underlying proxy models would entail the undermining of highly established theories and is thus unsubstantiated; and that historical data are not inferior to experimental data, but rather that these two types of data are essential complements.		
67	Jebeile and Crucifix	Ensemble of climate models or missed opportunity?
According to a common claim, the multi-model ensembles in the Coupled Model Intercomparison Project are not designed to properly span uncertainty ranges because of their opportunistic nature. We offer an argument for it: in building their models, climate scientists make choices of representation that can be guided by contextual values as well as collective and personal interests. We then mitigate the claim by arguing that, first, there is no optimal ensemble of models, and, second, even the possibility of coordinating worldwide model development, so to avoid values and interests, is not a guarantee for the quality of an ensemble.		
31	Lusk and Goldsby	The Decision-Relevancy of Climate Model Results: Idle Arguments or Idle Dreams?
Frigg et al. (2014) argue that even tiny differences between a complex dynamical model and the true structure of its target system can endanger policy decisions based upon such models. On the other hand, Winsberg and Goodwin suggest that Frigg et al.'s argument is "dangerous" and too hastily undermine large swaths of climate science. This paper seeks to attenuate this debate by establishing an irenic middle position; we find that there is more agreement between sides than it first seems. We establish criteria for decision-relevancy that shows how and where climate models can contribute to policy discussions.		