A Social Process in Science and its Content in a Simulation Program

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Abstract:

We lay open a position concerning the difference between scientific processes and processes in science. Not all processes in science are scientific. This leads into the center of social simulation. More scientific theories should be incorporated in social simulations, and this should lead to more united structural approaches.

Keywords: Social simulation, process, science, theory, social science, philosophy of science

The Question

The following question, which need to be taken more seriously, have been on our minds recently.

> Is every social process which happens in science a scientific process as well? To put it differently, are there processes of science that are social and not scientific?

An argument over a visit to the opera, taking place in the cafeteria of a scientific laboratory, seems to be a process in science, and it is surely a social action. A chemical reaction which takes place in a deserted laboratory is also a part of science. Is this process a social process, a social action as well?

Theoretical Aspects

Essentially, this question concern four theoretical concepts: process, social process, process of science, and scientific process. We are assuming that every social process and every process of science is a process, and we assume that the concept of sientific process does not have the same extension as the concept of process of science. On the practical side, also the concept of a computer run is a process. We will not go into further detail about these requirements here.

In normal speech, a social process is made up among other things of a collective action involving several people. A computer run would be an electrical current which in a very complex way flows and is regulated by technically subtle paths, junctions and joins. A process of science is a dynamic event which takes places in the area of science where different parts of the process can be added or taken away or the relationships between parts may be altered. A scientific process would be a process generated and intended by scientists at the right time and place. Wherein lies the difference then between a process of science and a scientific process?

Is a process where a file is printed a scientific process? Well, this is determined by then digitalized content found in the file. If the printed item contains data recently generated by a laboratory, then it clearly relates to a scientific process. If the file is about a paper which the author has just printed for the first time, than one could say to that a scientific process is involved. Is the printing of a thirty-year-old document off the internet by a laboratory worker for a researcher a *scientific* process? The facts found in such a document could be said to be somewhat stale. When a laboratory worker prints out a family picture because his home printer is broken, does this constitute something scientific? We will not proceed further with this line of thinking at time.

Instead we will discuss the meaning of these concepts in the languages of the scientific disciplines which are responsible: philosophy - especially philosophy of science and linguistics. In some regional languages *philosophy of science* can be better expressed by the terms *epistemology* and *theory of science*[1] which we will use therefore also in this paper.

Structuralistically, an *empirical theory* T has two parts: the *formal core* K which can be explicitly and completely described through a language and a set I of *intended applications*, meaning set theoretical representations of real systems which are intentionally studied by the members of this theorys *community.* The core contains among other things *models* and a *restriction relation.* This relation assigns to each model many 'reducts' which show, describe or represent[2] the *possible* data sets for the intended applications. An intended application of a theory is made up of elementary parts, i.e. made up of the (possible) data found or exist in this intended application. A complex system is described not only by data but also by *data sets.* A real fact can be a datum or a more complicated event 'seen' and studied from the perspective of this special theory T, *if* the fact is described in the vocabulary of theory T and if it 'is' a 'part' of an intended application of this theory.

A process is thus normally described, studied and 'seen' by a certain theory. Families of theories are pooled together to form larger areas, such as disciplines, whereby the concept of process is used in a similar meaning. For us, the central point is to specify the framework, the perspective, the perception or more exact: the theory indicated where a real process is studied and perceived. This point is described in detail in the structuralistic theory of science.[3]

As so many disciplines and theories use the concept of process we are choosing to remain at an abstract level. The 'pure' concept of process plays a central part in natural sciences and technology as well as in social studies and humanities. This central part is often discussed from two diametrically opposed world-views and has always been a topic of debate. In short, it is about the question how a datum which is derived or generated by a process can be 'seen'. On one hand there is the view point which is transcribed by terms such as realism,

[1] In the German language the word Wissenschaftstheorie is established.

[2] We are using an extended form of the structuralistic concept of an empirical theory described by (Balzer et al. 1993).

[3] (Diederich et al. 1989, 1994).

positivism, objectivism. From this point of view, a datum exists independently from the production and/or construction of said datum. For example in a questionnaire the question whether an object is ‘feminine’ or ‘masculine’ normally do not pose any real difficulties. Usually, the characteristic ‘feminine-masculine’ is not dependent on the method used in a questionnaire. On the other hand, in social constructivism, idealism and ethnomethodology, it is insisted that every datum used for investigating a system is socially constructed, produced and selected. In other words, all data had been made by people. Both perspectives have been fundamentally sharpened, for example in the last century there has been a ‘Historikerstreit’ in Germany, and later there was a debate about ‘positivism’ (Adorno 1969), (Giddens 1974). The terminology used to distinguish between scientific areas is also revealing. In English-speaking areas, the German term ‘Wissenschaften’ is translated and sorted into sciences and humanities whereby social sciences are categorized under humanities.

The frontline of this world-view runs not only between sciences and social science, but in ‘local’ areas as well. At the moment science studies and science research is at home in sociology whereas the theory of science is (still?) settled in philosophy. A researcher from science studies would view a studied system as an action system whereas a researcher from theory of science would see the ‘same’ system as a chemical reaction. One of the main themes involving both sides is the question what it means that a sociological hypothesis describes ‘the’ reality.[4]

This discussion does not change when we use the more general concept of process. Will physicists agree that the processes in a physical theory of gravitation are constructed socially? Will sociologists from science studies agree that the processes in the sociological balance theory of by Holland-Leinhard (Manhart 1995) are actually taking place regardless of whether they are studied in this theory or not? At this point we would like to revert to a more pragmatical path as opposed to pursuing these questions further.

Practical Aspects

We are drawing a boundary between these concepts but we will keep somewhat vague at this point. On one side, we find the ‘pure, real’ processes, on the other side, the ‘pure, social’. However most processes contain social as well as nonsocial (‘objective’) components. A process has many properties and relationships. Some of which are based on the social side, whereas others are based on non-human issues. Most processes contain both components but in different proportions.

In this way it is often possible to say, relative to a given process and relative to a given theory, which components of a process relative to the given theory are more important in the application of a special theory. Often in this situation it is possible to handle the afore mentioned questions a bit softer.

[4]See for example, from the sociological side (Bloor 1996), (Woolgar 1981) and from the realistic side (Giere 1998), (Searle 1995).

The properties and relations of a social process can be best described in a sociological theory. Along with sociology, psychology and political sciences can also be used. The term 'process of science' can be likewise categorized. Without further information on the contents, such a process is normally viewed from the perspective of science studies as a net of actions, sometimes it can be also studied in history of science. A process, however, happening in science does not need to have anything to do with the actions, at least on the surface. The printing process is an example of this. A process taking place in a computer would normally not be studied through sociology rather through computer sciences, possibly through mathematics and computer linguistics as well.

A local hierarchy can show which theory describes a specific scientific process best. This can be dependent on research interests, however. There are scientific processes whose main components touch on social aspects, others which are studied not with sociological theories but rather with theories from natural sciences. A real process of printing something out has, in view of the theory of physical rigid body mechanics, some properties ('some parts spin', 'other parts move in other ways', 'most of that parts are rigid'), which are not 'intended properties', for instance, in the field of medicine. Instead other things in this field such as harmful fumes or irritating noises are important.

To summarize, we think that one should answer the questions posed above in stages. Pragmatically, it seems rather clear that there are scientific processes that are not social processes. In the application of this concept, the theories from natural sciences are often so dominant that the social components aspects of meaning and action which reach into social areas, are not taken into account. An example of this is throwing a stone, which can be explained through Galileos laws. Aspects from other theories come into question only when different perspectives in terms of usage or from different discussions become necessary. When viewed from a distance, quasi objectively, the concept of a process can be understood in a philosophical way, where a process is an *event*.[5] This is in our opinion, the most common philosophical view. In the circa 2500 year old texts from Aristotle, it is possible to make out and trace the beginnings of disciplines such as physics, economics, sociology, political science, literature. In the end, our questions revert to general and philosophical areas and all processes have components which revert to social areas. This is because events can only be shared through language.

Our position is that, when viewed at a distance, it is best to categorize the concept of process of science to the sociological viewpoint, also, that the concept of scientific process is to be used in balance in the disciplines of science studies and theory of science. If we were to view the concept of scientific process as only an action-theoretical term than we would be giving up knowledge that already exists and is applied in other scientific branches.

Both these world-views exist symbiotically, whether they want to or not. A contact, the kind possible in physics, in which the experimental and the theoretical coexist symbiotically, can also be possible in the areas of science studies

[5]See (Davidson 2001) for example.

and theory of science. These areas could, if they wanted, examine real systems in a complementary but still cooperative way.

Social simulation

Our analysis of social processes can now also be applied to computer simulations. For us, a practical reference is important in this area. A central part of a simulation are the computer runs which are produced by a simulation program. A single computer run can be described and studied from several points of view. As we already stated, a layperson would describe a computer run as an electrical current flowing through the processors. A physicist would view the same process through electrodynamics, a computer manufacturer as the utilization of software, a computer programmer as the execution of program code, and a theoretical computer scientist as a sequence of bits. With a simulation of a social process, the program developer can perceive the process, the run, which he is looking at as a description of a social process depending on the images he has in his head while working.

In these different views of a simulation run it is possible to filter out specific parts which describe specific actions or distinct, in the right times, activated actors. When a program is written in a high level language, it is possible to categorize such parts to their corresponding programming lines in code. In other words, it is in normal language possible to classify computer runs and parts of a run in processes which 'are' social, scientific, 'of science', technical or 'from natural science'. In this formulation, these properties like social, scientific etc., are of course not 'directly' attributed to the real processes. Instead, they are 'conveyed' through the computer run, the program and the programing language. Put yet another way, a real process can be described by a computer process (or a partial process). The more a process is scientifically analyzed, the better the quality of the description becomes. In the clearest scenario, a real, social process can be directly assigned to a part of a computer process which is currently running by a simulation program (Balzer et al. 2008). We can take then the question formulated in the beginning and pose it for computer runs, although in a mediated form. The real question would be directed to the real process described. The mediated question is: are there partial processes of runs that describe processes of science and social aspects but in fact do not describe scientific processes or parts of them?

To answer this question we will give further structure to a simulation program. We are making a distinction in a program between the central program and the tools whereby in this case the term tool is used only in reference to programs or parts of programs. A tool contains program code which can be uploaded or erased by the central program. It has become clear that a complex simulation program needs tools. A computer programmer cannot understand the 'direct' output files containing result data any more. This situation is further harmed when little care is taken in formating the results. With pre-made tools the trouble of formating can often be in vain, however. We must know the statistical methods used in social disciplines. When a researcher wants to use a test of goodness of fit, he must reflect beforehand whether the test theoretically makes sense in his case.

The toolkit-approach, as it has come to be known, has developed in the last twenty years into a simulation method. The 'united' approach, where a complete simulation program is created out of the same 'mold' has fallen out of use. Software packages such as Netlogo, Swarm, Repast or the development environment and predefined applets in JAVA minimize the work of programmers by offering tools pre-made. Such tools free the programmer of many long hours writing annoying, complex codes.

There is a negative side to all of this, however. These types of software packets often have methodological gaps in certain areas, and/or contain parts which have not been published or are not always available, so that concrete scientific simulation programs often do not make the grade. Glaring examples of unpublished code include Sugarscape or the code from Netlogo. In the first euphoric phase of simulations, the toolkit approach was very practical, but after the first cool down problems begin to arise. For example, in certain applications the object orientation is so exaggerated, that they lead to a narrowing in scientific[6] methods.

If we describe the central program using a model, then on the one hand the model will contain a part which is represented on micro and macro level. The model describes the aspects, relations, and developments of a social process in science. On the other hand it is also possible that the simulated social process must respond implicitly to scientific contents, because without these the social process cannot be understood. For example, someone would like to simulate how the discovery of Mercurys Perihelion in 1915 became so quickly known in the world of physics. If one does not understand Einsteins equations, then how this social change took place cannot be explained. In other words, it is possible in a central program to use parts modules which represent scientific processes and in the extreme case: pure scientific processes, that are 'needed' by the program for the social process itself.

That this possibility, a module which describes a scientific process, is at the moment hardly utilized in the central program of a social simulation program for social systems seems contingent to us. This could change rapidly. In other words, the computer model could describe a scientific process from the viewpoint of social science but 'within' this model we could also find an nearly uncoupled partial model which represents a 'nonsocial' scientific model. We do not view this as a 'fundamental opposition' between models from the natural sciences and from the social sciences but as kinds of complementary and pragmatic approaches.

There is a lot to commend that the designers of a scientific simulation have a theory in the background. In the theory of science, the content of a theory is clearly described.[7] A concept of process can usually be defined from a re-

[6] The judicial regulations are not addressed here.

[7] (Balzer et al. 1987), Chap. 2.

construction of a theory. In simulations, we should use these theories and the acquired knowledge in this area. We can reformulate hypotheses from well known theories and take them as parts of a simulation program. This would have two positive effects. First we would be able to 'leap' over the historical-sociological hurdle to come to data which are generated with the help of a theory, even if they are no real data. Second, the simulation program would be linked with a scientific theory, which would be positive for both sides.

Lastly we would like to mention a social, non scientific yet often central, judicial-economic aspect. Is a special tool, legally protected and/or can be purchased? The method 'plug-in-and-work' is found mostly in the commercial level. With internet applications its okay to use a 'pure' object oriented strategy. In scientific simulation programs this very one-sided programming technique is reaching soon its limits. In social applications, the relations (or more object oriented: methods) often play a more central role. Of course it is mathematically possible to dissolve a complex relation into a hierarchical structure of simpler relations but it is in the same way clear that this can lead to NP-hard, or even undecidable problems.

Therefore the united programming approaches should not be cast aside. How this niche continues to develop is anyones guess. LISP seems to have fallen out of use. Prolog is not quite 'dead'. For example, it is still in use in the commercial Tivoli Enterprise Console (TEC) from IBM.[8]

Outlook

To conclude, we would like to formulate four special themes, which stem from our questions and their answers. And we think they make good sense. In science we find social processes that are mainly about a) the transfer of knowledge (learning and teaching), b) competition between researchers and projects, c) the influence[9] between science and society (for instance: 'spreading knowledge') and d) evaluation of research activities. In all these types of processes there is content in the simulation models, hidden to some extent, that stems from pertinent scientific theories. This content is implicitly or explicitly used in the simulation models.

We mean thus that a simulation of a social process in science, theories should be used which are relevant to the social process itself.

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[8] Several simulation programs (Balzer 2000), (Brendel 2010), (Doran et al. 1994), (Hofmann 2009), (Pitz 2000).

[9] (Balzer 1990).

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