Logic and Time

In my paper I try to show that (any) logic has much more to do with time than it is usually recognized. I argue that the fact that reasoning always takes time is not a peculiarity of our material constitution (and the material constitution of our world) but a necessary condition which makes reasoning possible. Finally I introduce the notion of internal time of logical system and rise the problem of relationships between physical time and internal time of logical system.

In the early era of Tensed logic Prior was puzzled by the suggestion that propositions might be changeable entities like physical objects - the possibility which allegedly was easily admitted by Scholastics after Aristotle but later definitely rejected by Frege. Although given a formal construction of tensed logic we could avoid to think about propositions in these terms considering temporal operators as modal ones, the suggestion seemingly stands behind the very idea of Tense logic. Prior discusses the idea of changeable propositions only in one aspect - he thinks of a situation when a proposition changes its truth-value, for example, when the true proposition *Socrates sits* becomes false because Socrates stands up. However the truth-value is not the **only** aspect of a proposition which matters logically. If we take the idea of changeable proposition seriously we can also think about other characteristics of a proposition which could change.

We would go obviously too far supposing that terms in a proposition could change its meanings, that rules, which govern the admitted proposition structure, might also change, etc. Although if we think about the real practice of argumentation such suppositions would not seem to be so bizarre as they seem to be at the first sight, they still take us too far away from what is usually called logic. (It might be also argued that though people often switch between different meanings of the same words and follow no permanent rules of argumentation, this performs examples of rather «illogical» than «logical» speech. If we believe that logic has a normative function, then we should rule out such examples as irrelevant. Notice however that normally we have no need to forbid changes of meanings of terms and rules of argumentation completely; we have to forbid only too

quick changes, i.e. changes within the same discussion. To put it in other words, the meanings and the rules should be stable locally but not necessarily universally.) But there is a way of how propositions change which has nothing to do with looseness and vagueness of ordinary speech or with the mutable nature of our physical world.

Think about a proof. To prove a proposition we have to take an unproved proposition and to make it proved. It certainly should be one and the same proposition - before and after the proof. Otherwise we could not say that we proved a certain proposition. Unlike the case of two different utterances *Socrates sits* made in two different times, in the case of a proof we have no reason to doubt whether we deal with two different homonymic propositions or with one and the same proposition. The latter option is the only reasonable.

A way to avoid the conclusion that proving a proposition we change it, is to say that «to be proved» and «to be unproved» are not something like properties of a proposition but rather are about our believes about the proposition, i.e. that «proved» and «unproved» are something like subjective attitudes toward the proposition in question. Then it might be argued that the difference between «A is proved» and «A is unproved» marks a change of a subjective attitude toward A but not a change of A itself. But this argument is obviously wrong because a proof might be called objective exactly in the same sense as a proposition. As well as we speak about truth-values of propositions abstracting from anybody's believes about these propositions, we speak about validity of proofs abstracting from their persuasiveness. Notice that to claim that a proof essentially involves change and hence time, we should not necessary to suppose that the difference between the situation, when proposition A is proved, and the situation, when A is unproved, marks a change *of A*. It is also possible to say that it is an «environment» or a «context» or a «position» of A that changes here. The attempt to distinguish between intrinsic and extrinsic characteristics of a proposition would be seemingly misleading. What is changing and what is constant here - a proposition or its «environment» or both - is rather a question of «choice of frame».

The situation when a proposition is proved is apparently not the only one when the same proposition appears more than once in reasoning. The possibility to repeat a proposition

differs it from every utterance of this proposition. (Actually this is already true about a corresponding language expression of a proposition, but for a proposition itself they suppose more: the possibility to vary not only via utterances but also via language expressions.) Obviously identifying propositions with utterances we would lose all the generality of logic and hence all the matter of logic as such. Thinking after Frege that propositions like *Socrates sits* uttered in different times are different (and incomplete), we make a step in this wrong direction. That is why Prior's attempt to think otherwise accepting changeable propositions, which gave birth to Tensed logic, is of general significance for logic. My suggestion is to extend Prior's (and the old traditional) understanding of how propositions can change to include other sorts of change than change of truth-value. It is interesting to note, that to undergo a change from being unproved to being proved a proposition should **not** simultaneously undergo a change of its truth-value. For a proved proposition should remain true during all the time of the proof. We see that such a **process** as a proof of a proposition becomes possible only with a condition that another process, namely change of the proposition's truth value, is stopped.

Hintikka in *The Principles of Mathematics Revisited*, ch.2 distinguishes between descriptive and deductive functions of logic: the former is about «expressing the content of ... propositions» and concerns semantics while the latter is about making inferences and proofs. Hintikka claims that the former unlike the latter was often underestimated and nearly neglected. In the province of Tensed logic however the situation looks differently: the discussion concerns more the «semantic mutability», i.e. the mutability of things which make propositions true, than the «deductive mutability», i.e. the mutability resulted from logical operations like inference. While the semantic mutability presupposes physical time, the deductive mutability presupposes what might be called an «internal» time of given logical system. An interesting question is not which of the two is more important but how they relate to each other. An answer for a particular case was given above: to proceed a proof of a proposition we need to stop all the physical processes which might cause becoming the proposition false before it is proven. However the whole question remains open.