Prof. Dr. Alfred Toth

Linear, nonlinear and multi-linear semiotic time

> A sign is an incomplete and dependent being. Time is a feature, a dependent and incomplete real being, a sign of reality, but not reality itself. However, insofar as moment and duration are modes of being of this time, they are also signs of real time and of reality, of historical as well as of physical time.
>
> Max Bense (1954, p. 8)

1. In his "Handbook of Semiotics", Nöth states that time is "a fundamental dimension for almost all semiotic systems and processes". However, its investigation has been carried out "hitherto hardly in explicitly semiotic connections" (Nöth 1985, p. 375). Nevertheless, although formal devices to analyze semiotic time are still practically absent, semiotics of time has been established as an own branch of semiotics under the name of "chronemics" (Bruneau 1977, Poyatos 1976). Given this deplorable situation, it is the aim of the present study to develop some fundamentals of a semiotic analysis of time by means of mathematical semiotics. (Toth 2007).

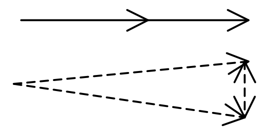
2. According to Bense (1971, pp. 33 ss.), a sign is introduced by an "interpreter" (.3.) for an "object" (.2.) by aid of a "medium" (.1.) in this order (.3. > .2. > .1.). Yet, the reality thematic of a sign class is given in the reverse order (.1. > .2. > .3.). Moreover, communication schemes have the order (.2. > .1. > .3.) (Bense 1971, p. 40), and creation schemes have the order (.3. > .1. > .2.) (Bense 1979, pp. 68 ss.). Thus, the order of the respective reality thematics is for communication schemes (.3. > .1. > .2.) and for creation schemes (.2. > .1. > .3.). Therefore, completing the possible permutations by the order (.2. > .3. > .1.), we get the following 6 possible semiotic orders:

(.3. > .2. > .1.)	(.1. > .2. > .3.)
(.3. > .1. > .2.)	(.2. > .1. > .3.)
(.1. > .3. > .2.)	(.2. > .3. > .1.)

Since the transformation of an object into a meta-object and thus into a sign (Bense 1971, p. 9) needs time, we can associate each triadic value of a sign class or reality thematic in all its transpositions given above with a time-point t_i (i = 1, 2, 3). The "generative" (>) and "degenerative" (<) relations between the triadic values thus become relations of time-order, the sign itself gets a time-structure, and we may thus visualize the time-structures involved in the semiotic representation schemes by the diagrams to the right of the following table in which time-orders of reality thematics are dashed:

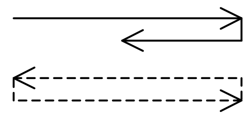
(3.1 2.1 1.3) × (3.1 1.2 1.3)

$t_1 > t_2 > t_3$ $\quad$ $t_1 > t_2 = t_3$



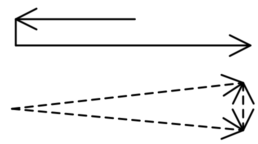
(3.1 1.3 2.1) × (1.2 3.1 1.3)

$t_1 > t_3 < t_2$ $\quad$ $t_1 < t_2 > t_3$



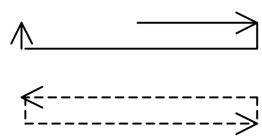
(2.1 3.1 1.3) × (3.1 1.3 1.2)

$t_2 < t_1 > t_3$ $\quad$ $t_1 > t_2 = t_3$



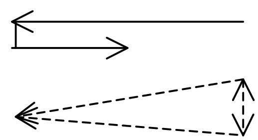
(2.1 1.3 3.1) × (1.3 3.1 1.2)

$t_2 > t_3 < t_1$ $\quad$ $t_1 < t_2 > t_3$



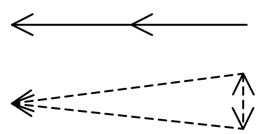
(1.3 3.1 2.1) × (1.2 1.3 3.1)

$t_3 < t_1 > t_2$ $\quad$ $t_1 = t_2 < t_3$



(1.3 2.1 3.1) × (1.3 1.2 3.1)

$t_3 < t_2 < t_1$ $\quad$ $t_1 = t_2 < t_3$



As the diagrams of time-order show, time is anything else than a "one-dimensional semiotic phenomenon" (Nöth 1975, p. 376). Furthermore, in semiotics, the formal analysis of time turns out to be much more complex than in classical as well as in relativistic physics. We may thus interpret the above diagrams as follows: While the arrows that lead from the left to the right over all triadic values represent **chronological** semiotic time, the respective reverse arrows are representations of **non-chronological** time. Arrows that connect only two triadic values represent **flashbacks** (analepsis) and **flash-forwards** (prolepsis). Only diagrams with single arrows in the same direction can be interpreted as semiotic representations of **linear time**; the other ones represent **nonlinear** time-orders. The time-structures of the transpositional sign classes (2.1 3.1 1.3) and (2.1 1.3 3.1) are instances of a "**medias in res**" time-order. Most interesting is the result that the time-orders of all reality thematics are **circular** (over all or two triadic values).

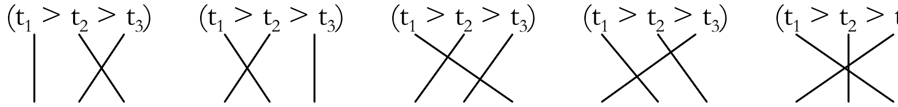
3. In addition, the above time-structures allows to differentiate between time-points and time-order insofar as the following diagrams contain different time-points but identical time-orders:

$$\left.\begin{array}{l}(3.1 \quad 1.3 \quad 2.1) \times (1.2 \quad 3.1 \quad 1.3)\\ (2.1 \quad 1.3 \quad 3.1) \times (1.3 \quad 3.1 \quad 1.2)\end{array}\right\} (t_2 > t_3 < t_1) \times (t_1 < t_2 > t_3)$$

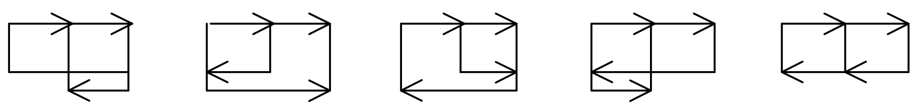
$$\left.\begin{array}{l}(2.1 \quad 3.1 \quad 1.3) \times (3.1 \quad 1.3 \quad 1.2)\\ (1.3 \quad 3.1 \quad 2.1) \times (1.2 \quad 1.3 \quad 3.1)\end{array}\right\} (t_3 < t_1 > t_2) \times (t_1 = t_2 < t_3)$$

4. The 6 possible transpositions of each sign class and reality thematic can be combined to 5 + 4 + 3 + 2 + 1 = 15 non-identical combinations of time-structures for the same sign class and reality thematic which are shown using the sign class (3.1 2.1 1.3):

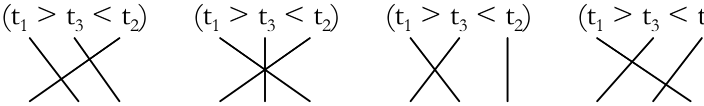
(3.1 2.1 1.3)	(3.1 2.1 1.3)	(3.1 2.1 1.3)	(3.1 2.1 1.3)	(3.1 2.1 1.3)
$(t_1 > t_2 > t_3)$	$(t_1 > t_2 > t_3)$	$(t_1 > t_2 > t_3)$	$(t_1 > t_2 > t_3)$	$(t_1 > t_2 > t_3)$



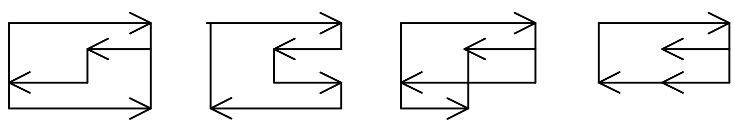
$(t_1 > t_3 < t_2)$	$(t_2 < t_1 > t_3)$	$(t_2 > t_3 < t_1)$	$(t_3 < t_1 > t_2)$	$(t_3 < t_2 < t_1)$
(3.1 1.3 2.1)	(2.1 3.1 1.3)	(2.1 1.3 3.1)	(1.3 3.1 2.1)	(1.3 2.1 3.1)



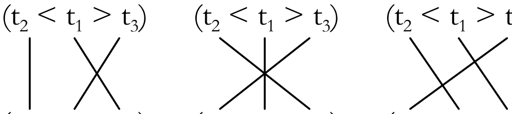
(3.1 1.3 2.1)	(3.1 1.3 2.1)	(3.1 1.3 2.1)	(3.1 1.3 2.1)
$(t_1 > t_3 < t_2)$	$(t_1 > t_3 < t_2)$	$(t_1 > t_3 < t_2)$	$(t_1 > t_3 < t_2)$



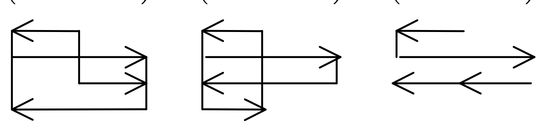
$(t_2 < t_1 > t_3)$	$(t_2 > t_3 < t_1)$	$(t_3 < t_1 > t_2)$	$(t_3 < t_2 < t_1)$
(2.1 3.1 1.3)	(2.1 1.3 3.1)	(1.3 3.1 2.1)	(1.3 2.1 3.1)



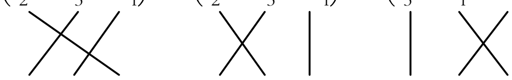
(2.1 3.1 1.3)	(2.1 3.1 1.3)	(2.1 3.1 1.3)
$(t_2 < t_1 > t_3)$	$(t_2 < t_1 > t_3)$	$(t_2 < t_1 > t_3)$



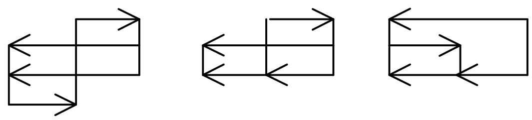
$(t_2 > t_3 < t_1)$	$(t_3 < t_1 > t_2)$	$(t_3 < t_2 < t_1)$
(2.1 1.3 3.1)	(1.3 3.1 2.1)	(1.3 2.1 3.1)



(2.1 1.3 3.1)	(2.1 1.3 3.1)	(1.3 3.1 2.1)
($t_2 > t_3 < t_1$)	($t_2 > t_3 < t_1$)	($t_3 < t_1 > t_2$)

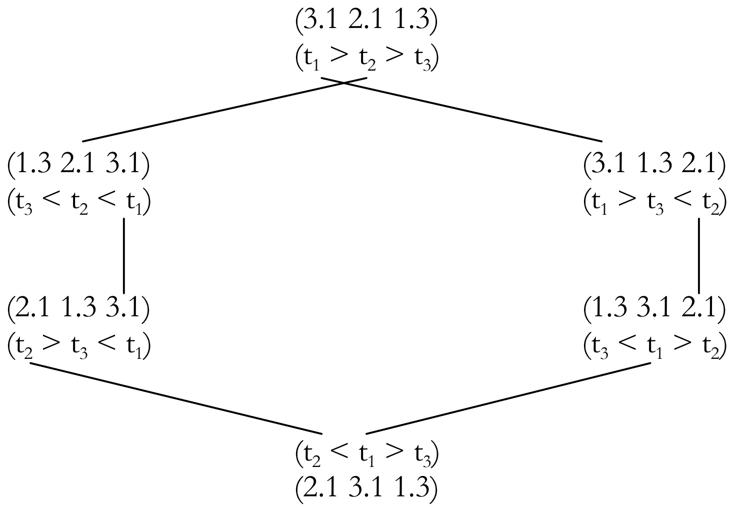


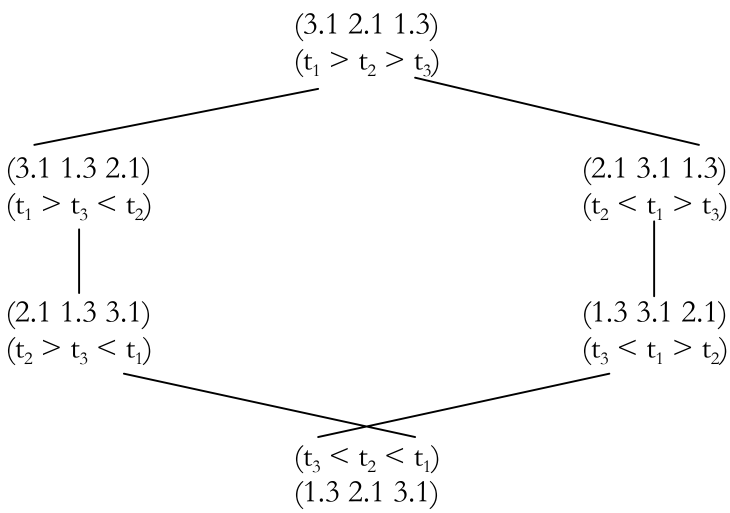
($t_3 < t_1 > t_2$)	($t_3 < t_2 < t_1$)	($t_3 < t_2 < t_1$)
(1.3 3.1 2.1)	(1.3 2.1 3.1)	(1.3 2.1 3.1)

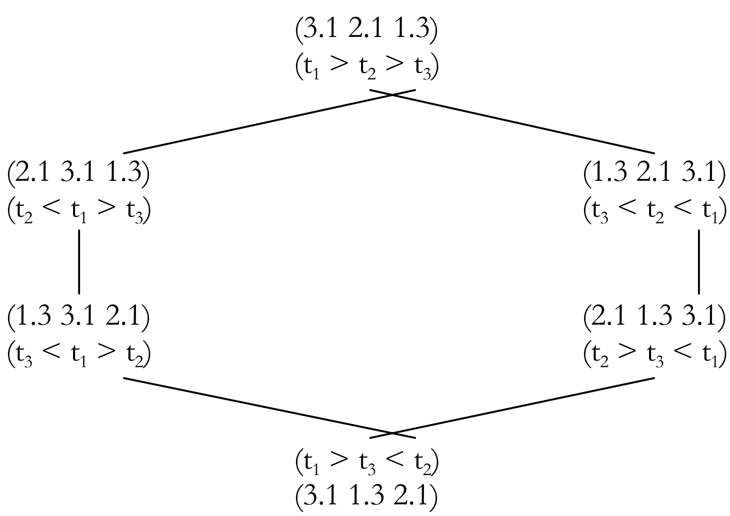


It is clear, that besides these elementary possibilities for multi-linear semiotic structures built from two times-orders, much more complex structures of time-order may be constructed or analyzed, and especially combinations of non- and multi-linear orders. The most important source for time-structure analysis is film. When Godard said: "I agree that a film should have a beginning, a middle and an end, but not necessarily in that order" (The Observer, November 26, 2000), we may see in the above schemes the most basic semiotic representations of linear, nonlinear and multi-linear time orders. The same holds for Andy Warhol's "Chelsea Girls" (1968), probably the first film with completely randomized chronology (cf. Dethridge 2003). While simple sign classes and reality thematics can be analyzed by means of semiotic vectors (cf. Toth 2007, pp. 48 s.), transpositions of sign classes and reality thematics can be analyzed by aid of semiotic tensors (cf. Toth 2008a, pp. 105-109), mathematical semiotics thus paralleling linear and multi-linear algebra. However, as the above diagrams show, semiotic time is linear only in the case of the simple sign class and its reality thematic and non-linear in all other cases. Moreover, since the semiotic law of the auto-reproduction of the sign (cf. Bense 1976, pp. 163 s.) states that no sign can appear alone, hence signs appear in connections such as semiotic structures, systems and processes, it follows that semiotic time-structures are mostly multi-linear. This latter fact is for instance used by video games that usually have more than one possible plot-line and ending.

5. In order to visualize complex non- and multi-linear semiotic time structures, we first show three cyclic connections of the time-structures involved in transpositions of sign classes and reality thematics by connecting identical time-points, using again the sign class (3.1 2.1 1.3) as example:


(3.1 2.1 1.3)
$(t_1 > t_2 > t_3)$
(1.3 2.1 3.1)
$(t_3 < t_2 < t_1)$
(3.1 1.3 2.1)
$(t_1 > t_3 < t_2)$
(2.1 1.3 3.1)
$(t_2 > t_3 < t_1)$
(1.3 3.1 2.1)
$(t_3 < t_1 > t_2)$
$(t_2 < t_1 > t_3)$
(2.1 3.1 1.3)


(3.1 2.1 1.3)
$(t_1 > t_2 > t_3)$
(3.1 1.3 2.1)
$(t_1 > t_3 < t_2)$
(2.1 3.1 1.3)
$(t_2 < t_1 > t_3)$
(2.1 1.3 3.1)
$(t_2 > t_3 < t_1)$
(1.3 3.1 2.1)
$(t_3 < t_1 > t_2)$
$(t_3 < t_2 < t_1)$
(1.3 2.1 3.1)


(3.1 2.1 1.3)
$(t_1 > t_2 > t_3)$
(2.1 3.1 1.3)
$(t_2 < t_1 > t_3)$
(1.3 2.1 3.1)
$(t_3 < t_2 < t_1)$
(1.3 3.1 2.1)
$(t_3 < t_1 > t_2)$
(2.1 1.3 3.1)
$(t_2 > t_3 < t_1)$
$(t_1 > t_3 < t_2)$
(3.1 1.3 2.1)

6. After having shown instances of cyclic semiotic structures of time-order, we may ask which combinations of the time-structures involved in the transpositions of sign classes or reality thematics are finite and which ones are infinite. Moreover, paralleling the method used in Toth (2008b), we may differentiate between the lengths (L) of semiotic time-cycles:

1st cycle:

1. (3.1 2.1 1.3) → (1.3 2.1 3.1) → (3.1 2.1 1.3)
   $(t_1 > t_2 > t_3) \rightarrow (t_3 < t_2 < t_1) \rightarrow (t_1 > t_2 > t_3)$, L = 3

2. (3.1 1.3 2.1) → (2.1 1.3 3.1) → (3.1 1.3 2.1) → ∞
   $(t_1 > t_3 < t_2) \rightarrow (t_2 > t_3 < t_1) \rightarrow (t_1 > t_3 < t_2) \rightarrow \infty$

3. (2.1 3.1 1.3) → (1.3 3.1 2.1) → (2.1 3.1 1.3) → ∞
   $(t_2 < t_1 > t_3) \rightarrow (t_3 < t_1 > t_2) \rightarrow (t_2 < t_1 > t_3) \rightarrow \infty$

4. (2.1 1.3 3.1) → (3.1 1.3 2.1) → (2.1 1.3 3.1) → ∞
   $(t_2 > t_3 < t_1) \rightarrow (t_1 > t_3 < t_2) \rightarrow (t_2 > t_3 < t_1) \rightarrow \infty$

5. (1.3 3.1 2.1) → (2.1 3.1 1.3) → (1.3 3.1 2.1) → ∞
   $(t_3 < t_1 > t_2) \rightarrow (t_2 < t_1 > t_3) \rightarrow (t_3 < t_1 > t_2) \rightarrow \infty$

6. (1.3 2.1 3.1) → (3.1 2.1 1.3) → (1.3 2.1 3.1) → ∞
   $(t_3 < t_2 < t_1) \rightarrow (t_1 > t_2 > t_3) \infty (t_3 < t_2 < t_1) \rightarrow \infty$

2nd cycle:

1. (3.1 2.1 1.3) → (2.1 1.3 3.1) → (1.3 3.1 2.1) → (3.1 2.1 1.3)
   $(t_1 > t_2 > t_3) \rightarrow (t_2 > t_3 < t_1) \rightarrow (t_3 < t_1 > t_2)$, L = 3

2. (3.1 1.3 2.1) → (1.3 2.1 3.1) → (2.1 3.1 1.3) → (3.1 1.3 2.1) → ∞
   $(t_1 > t_3 < t_2) \rightarrow (t_3 < t_2 < t_1) \rightarrow (t_2 < t_1 > t_3) \rightarrow (t_1 > t_2 > t_3) \rightarrow \infty$

3. (2.1 3.1 1.3) → (3.1 1.3 2.1) → (1.3 2.1 3.1) → (2.1 3.1 1.3) → ∞
   $(t_2 < t_1 > t_3) \rightarrow (t_1 > t_3 < t_2) \rightarrow (t_3 < t_2 < t_1) \rightarrow (t_2 < t_1 > t_3) \rightarrow \infty$

4. (2.1 1.3 3.1) → (1.3 3.1 2.1) → (3.1 2.1 1.3) → (2.1 1.3 3.1)
   $(t_2 > t_3 < t_1) \rightarrow (t_3 < t_1 > t_2) \rightarrow (t_1 > t_2 > t_3) \rightarrow (t_2 > t_3 < t_1)$, L = 4

5. (1.3 3.1 2.1) → (3.1 2.1 1.3) → (2.1 1.3 3.1) → (1.3 3.1 2.1)
   $(t_3 < t_1 > t_2) \rightarrow (t_1 > t_2 > t_3) \rightarrow (t_2 > t_3 < t_1) \rightarrow (t_3 < t_1 > t_2)$, L = 4

6. (1.3 2.1 3.1) → (2.1 3.1 1.3) → (3.1 1.3 2.1) → (1.3 2.1 3.1) → ∞
   $(t_3 > t_2 > t_1) \rightarrow (t_2 < t_1 < t_3) \rightarrow (t_1 > t_3 > t_2) \rightarrow (t_3 < t_2 < t_1) \rightarrow \infty$

3rd Cycle:

1. (3.1 2.1 1.3) $\rightarrow$ (1.3 3.1 2.1) $\rightarrow$ (2.1 1.3 3.1) $\rightarrow$ (3.1 2.1 1.3)
   $(t_1 > t_2 > t_3) \rightarrow (t_3 < t_1 > t_2) \rightarrow (t_2 < t_3 > t_1) \rightarrow (t_1 > t_2 > t_3)$, L = 4

2. (3.1 1.3 2.1) $\rightarrow$ (2.1 3.1 1.3) $\rightarrow$ (1.3 2.1 3.1) $\rightarrow$ (3.1 1.3 2.1) $\rightarrow \infty$
   $(t_1 > t_3 < t_2) \rightarrow (t_2 < t_1 > t_3) \rightarrow (t_3 < t_2 < t_1) \rightarrow (t_1 > t_3 < t_2) \rightarrow \infty$

3. (2.1 3.1 1.3) $\rightarrow$ (1.3 2.1 3.1) $\rightarrow$ (3.1 1.3 2.1) $\rightarrow$ (2.1 3.1 1.3) $\rightarrow \infty$
   $(t_2 < t_1 > t_3) \rightarrow (t_3 < t_2 < t_1) \rightarrow (t_1 > t_3 < t_2) \rightarrow (t_2 < t_1 > t_3) \rightarrow \infty$

4. (2.1 1.3 3.1) $\rightarrow$ (3.1 2.1 1.3) $\rightarrow$ (1.3 3.1 2.1) $\rightarrow$ (2.1 1.3 3.1)
   $(t_2 > t_3 < t_1) \rightarrow (t_1 > t_2 > t_3) \rightarrow (t_3 < t_1 > t_2) \rightarrow (t_2 > t_3 < t_1)$, L = 4

5. (1.3 3.1 2.1) $\rightarrow$ (2.1 1.3 3.1) $\rightarrow$ (3.1 2.1 1.3) $\rightarrow$ (1.3 3.1 2.1)
   $(t_3 < t_1 > t_2) \rightarrow (t_2 > t_3 < t_1) \rightarrow (t_1 > t_2 > t_3) \rightarrow (t_3 < t_1 > t_2)$, L = 4

6. (1.3 2.1 3.1) $\rightarrow$ (3.1 1.3 2.1) $\rightarrow$ (2.1 3.1 1.3) $\rightarrow$ (1.3 2.1 3.1) $\rightarrow \infty$
   $(t_3 < t_2 < t_1) \rightarrow (t_1 > t_3 < t_2) \rightarrow (t_2 < t_1 > t_3) \rightarrow (t_3 < t_2 < t_1) \rightarrow \infty$

Thus, only the following semiotic time-structures are finite:

$(\underline{3.1\ 2.1\ 1.3}) \rightarrow (1.3\ 2.1\ 3.1) \rightarrow (\underline{3.1\ 2.1\ 1.3})$
$(\underline{t_1 > t_2 > t_3}) \rightarrow (t_3 < t_2 < t_1) \rightarrow (\underline{t_1 > t_2 > t_3})$

L = 3

$(\underline{3.1\ 2.1\ 1.3}) \rightarrow (2.1\ 1.3\ 3.1) \rightarrow (1.3\ 3.1\ 2.1) \rightarrow (\underline{3.1\ 2.1\ 1.3})$
$(\underline{t_1 > t_2 > t_3}) \rightarrow (t_2 > t_3 < t_1) \rightarrow (t_3 < t_1 > t_2) \rightarrow (\underline{t_1 > t_2 > t_3})$

$(\underline{3.1\ 2.1\ 1.3}) \rightarrow (1.3\ 3.1\ 2.1) \rightarrow (2.1\ 1.3\ 3.1) \rightarrow (\underline{3.1\ 2.1\ 1.3})$
$(\underline{t_1 > t_2 > t_3}) \rightarrow (t_3 < t_1 > t_2) \rightarrow (t_2 > t_3 < t_1) \rightarrow (\underline{t_1 > t_2 > t_3})$

$(\underline{2.1\ 1.3\ 3.1}) \rightarrow (1.3\ 3.1\ 2.1) \rightarrow (3.1\ 2.1\ 1.3) \rightarrow (\underline{2.1\ 1.3\ 3.1})$
$(\underline{t_2 > t_3 < t_1}) \rightarrow (t_3 < t_1 > t_2) \rightarrow (t_1 > t_2 > t_3) \rightarrow (\underline{t_2 > t_3 < t_1})$

$(\underline{2.1\ 1.3\ 3.1}) \rightarrow (3.1\ 2.1\ 1.3) \rightarrow (1.3\ 3.1\ 2.1) \rightarrow (\underline{2.1\ 1.3\ 3.1})$
$(\underline{t_2 > t_3 < t_1}) \rightarrow (t_1 > t_2 > t_3) \rightarrow (t_3 < t_1 > t_2) \rightarrow (\underline{t_2 > t_3 < t_1})$

$(\underline{1.3\ 3.1\ 2.1}) \rightarrow (3.1\ 2.1\ 1.3) \rightarrow (2.1\ 1.3\ 3.1) \rightarrow (\underline{1.3\ 3.1\ 2.1})$
$(\underline{t_3 < t_1 > t_2}) \rightarrow (t_1 > t_2 > t_3) \rightarrow (t_2 > t_3 < t_1) \rightarrow (\underline{t_3 < t_1 > t_2})$

$(\underline{1.3\ 3.1\ 2.1}) \rightarrow (2.1\ 1.3\ 3.1) \rightarrow (3.1\ 2.1\ 1.3) \rightarrow (\underline{1.3\ 3.1\ 2.1})$
$(\underline{t_3 < t_1 > t_2}) \rightarrow (t_2 > t_3 < t_1) \rightarrow (t_1 > t_2 > t_3) \rightarrow (\underline{t_3 < t_1 > t_2})$

L = 4

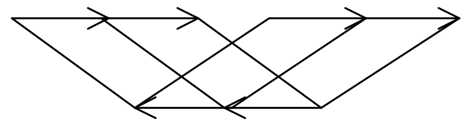
7. According to the two possible lengths of the semiotic time-cycles, that are necessary to get from one time-structure to the next upcoming identical time-structure, we get the following types of cyclic time-structures:

1[st] type:

The first type of semiotic time-cycles has a cyclic length L = 3 (as we have done above, we count all n vertices of the respective graphs):

(3.1 2.1 1.3) → (3.1 2.1 1.3)
($t_1 > t_2 > t_3$) → ($t_1 > t_2 > t_3$)

($t_3 < t_2 < t_1$)
(1.3 2.1 3.1)



2[nd] type:

The second type of semiotic time-cycles has a cyclic length L = 4. It shows up in 3 sub-types:

(3.1 2.1 1.3) → (3.1 2.1 1.3)
($t_1 > t_2 > t_3$) → ($t_1 > t_2 > t_3$)

($t_3 < t_1 > t_2$) → ($t_2 > t_3 < t_1$)
(1.3 3.1 2.1) → (2.1 1.3 3.1)

(3.1 2.1 1.3) → (3.1 2.1 1.3)
($t_1 > t_2 > t_3$) → ($t_1 > t_2 > t_3$)

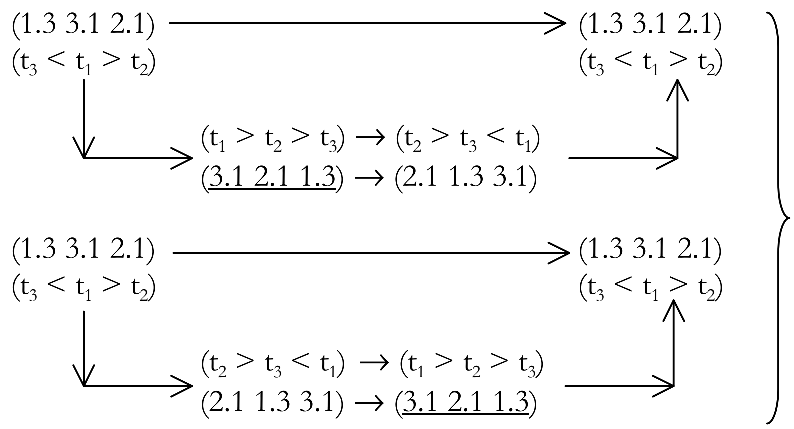
($t_2 > t_3 < t_1$) → ($t_3 < t_1 > t_2$)
(2.1 1.3 3.1) → (1.3 3.1 2.1)

(2.1 1.3 3.1) → (2.1 1.3 3.1)
($t_2 > t_3 < t_1$) → ($t_2 > t_3 < t_1$)

($t_3 < t_1 > t_2$) → ($t_1 > t_2 > t_3$)
(1.3 3.1 2.1) → (3.1 2.1 1.3)

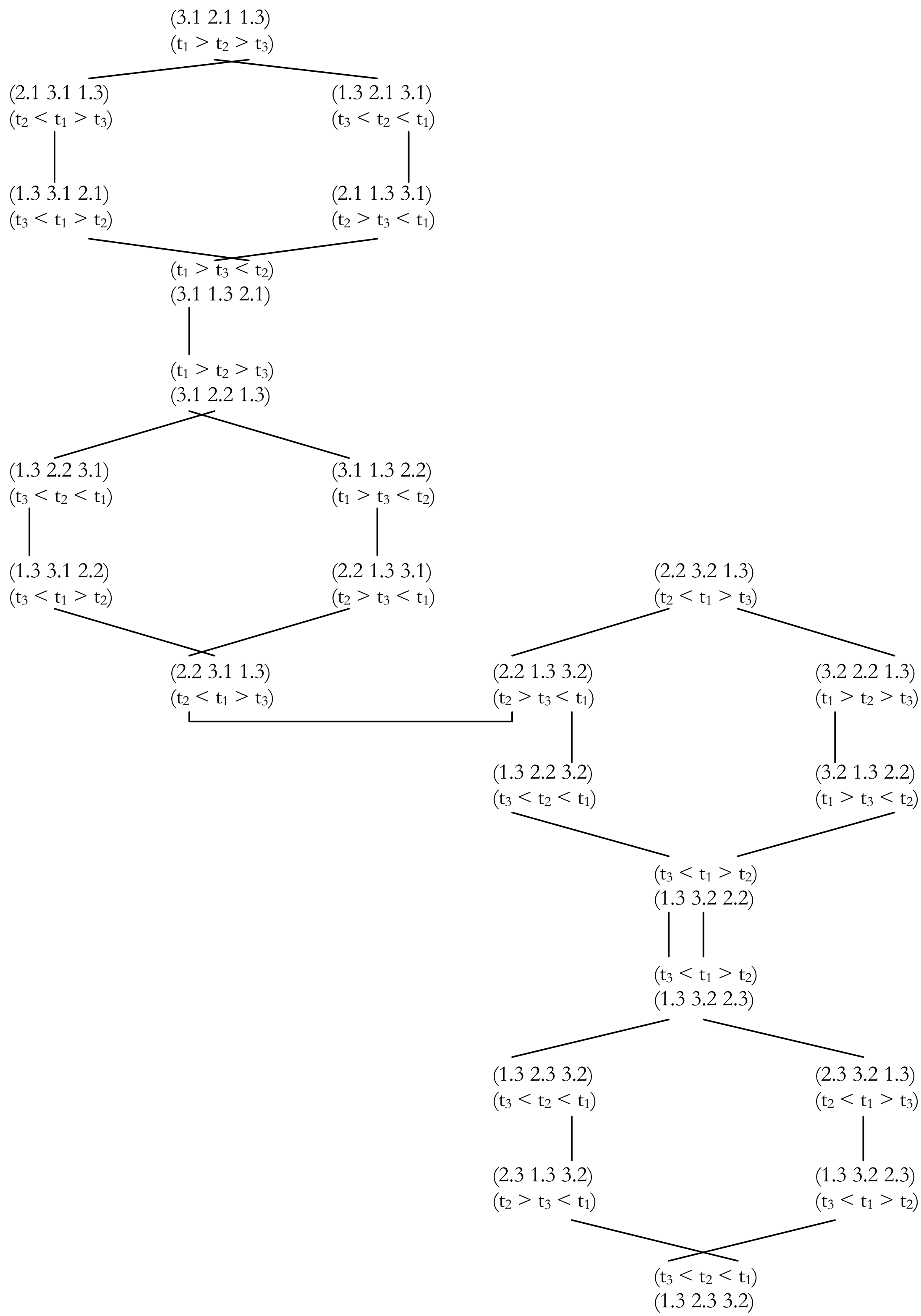
(2.1 1.3 3.1) → (2.1 1.3 3.1)
($t_2 > t_3 < t_1$) → ($t_2 > t_3 < t_1$)

($t_1 > t_2 > t_3$) → ($t_3 < t_1 > t_2$)
(3.1 2.1 1.3) → (1.3 3.1 2.1)



Since the above schemes have the general structure of informational schemes, these semiotic time-cycles involve representations of **temporal feedback**, i.e. time-configurations in cyclic relations that provide semiotic connections to reach the starting point in narrative and other time-bound structures. Therefore, they may be interpreted, e. g., as semiotic representations of the idea of "wheels of time" such as the Buddhist Kalachakra. Moreover, since the structural realities presented in the reality thematics of the transpositions of the sign classes correspond to the cybernetic system-and-environment distinctions, each time-structure can be associated with the epistemological trichotomy of subjective subject-objective subject and object (cf. Toth 2008c). Therefore, the time-structured get contextuated, and **semiotic time appears to be contextuated time**.

8. In order to finish this first theoretic overview of a semiotic analysis of time, I present a small fragment of complex semiotic time-structures, comprising the sign classes (3.1 2.1 1.3), (3.1 2.2 1.3) and (3.2 2.2 1.3) and showing linear, nonlinear and multi-linear time connections. The respective diagrams can be drawn in accordance to the elementary combinations presented in parts 2 and 3.



The above fragment may represent a part of a film-sequence with the sign classes representing various aspects of the stream of pictures, the transpositions the standpoints of the observers (protagonist, supporting roles, watcher, etc.) contextuated with the chronological or non-chronological (linear, non- and multi-linear) time-order in the stream of pictures. Since the sign classes involved may also belong to different scenes, the above diagram may also represent the semiotic, epistemological and temporal intersections of scenes or actions. Therefore, the model of semiotic analysis of time presented here may be useful for a mathematical film-semiotics, especially for the various connections between image and time (cf. Pasolini 1972a, 1972b). The dissertation of Beckmann (1977) which was supposed to present a "formal and functional analysis of film and television" proved to be a failure both in theoretical and applicable respects. The other models of film semiotics are not compatible with theoretical semiotics and thus neither with mathematical semiotics.

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