On the long term behaviour of the performance-potential-Metamodel PerPot

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PerPot has been developed for modelling, simulating and optimising the interaction between load and performance in training processes in sport but can be used for modelling general physiological adaptation processes as well. The basic idea of PerPot is as follows (also see Mester & Perl, 2000; Perl & Mester, 2001): A time-dependent load input b(t) feeds in an identical way two buffer potentials SP (strain potential) and RP (response potential), from which a performance potential PP is fed by specifically delayed antagonistic flows – which means that the response flow from RP to PP increases the performance, where the strain flow from SP to PP reduces it. Examples of application using different interpretations of the terms "load" and "performance" are documented in Perl, 2001.

Analyses of the functional behaviour of PerPot show the following effects, which are primarily interesting under the aspect of model dynamics but also can be discussed under the aspect of similarity to physiological phenomena:

(a) Independent on time and load input, the internal load balance of PerPot has a constant value only depending on the initial values of the potentials. The reason is that load input does not effect substantial increments but only effects a re-distribution of the available amount of potential substance. In so far, load just plays the role of a pump. However, too intensive or fast pumping can cause that single potentials get overflows or run empty, which means a temporarily irreversible loss of stability.

(b) The quality of PerPot-simulation can be increased by adding atrophy components. Due to (a), two different types of atrophy have to be distinguished: Temporary atrophy, which does not affect the constant balance property, has mathematically to be modelled by a delayed re-flow from the performance potential PP to the response potential RP. So on the one hand the current performance is reduced by temporary atrophy. On the other hand, the increased response potential effects an initially delayed but then speeded up recovering of the performance value. Quite different, the life long atrophy, modelled as an output flow, reduces the amount of performance substantially. This effect changes the internal balance of the model and cannot be compensated by additional load.

(c) The delay parameters determine the behaviour of the model. In particular, changing these parameters changes the asymptotically reachable maximum value of the performance potential. However, changing model parameters, consequently means changing the model – or adapting the model to a changing system. This aspect opens a new view to the modelling of training by coupling two PerPots: An outer PerPot, which models the temporary or short term interaction between load and performance, is itself influenced by an inner PerPot, which in particular effects the delay parameter of the outer one and so can improve its long term training results substantially. For example, load input to the inner model can cause a reduction of the response delay of the outer model, which then not only increases the maximum value of performance but

also speeds up the increasing process of performance – without any violation of balance. In the long run, however, speeding up the pumping process this way can cause performance reduction and serious instability of the whole system (as has been pointed out in (a)).

The presented aspects regarding atrophy and long term behaviour of PerPot show a certain analogy to that of adaptive systems like athletes. So, as already has been done with the temporary load-performance-interaction using PerPot, simulation can help to better understand and optimise long term training under the aspects of atrophy and improving parameters. Finally, aspects of life-long-training have to be discussed in order to avoid instability, break downs, or even sudden death phenomena.

References

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