

# An Agent Model for a Human's Functional State and Performance

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## Abstract

*This paper presents an agent model of the dynamics of a human's functional state in relation to task performance and environment. It can be used in agent systems that support humans in demanding circumstances. Simulation experiments under different parameter settings pointed out that the model is able to produce realistic behaviour of different types of personalities. Moreover, by a mathematical analysis the equilibria of the model have been determined, and by automated checking a number of expected properties of the model have been confirmed.*

## 1. Introduction

For a human functioning in demanding circumstances, the quality of performance may be a critical factor. Examples of such situations are military officers during a mission or air traffic controllers. In cases like these any performed action which is badly chosen, or simply suboptimal can lead to dramatic consequences. To avoid this, it often is of importance to maintain a high performance quality.

However, as is known from literature such as [5], [7] working under high pressure in demanding circumstances often entails negative effects on the human's functional state, which in turn easily may affect performance quality. A main question taken as a point of departure in this paper is to explore what is required to provide adequate support of a human functioning in demanding circumstances. Given its impact on performance as sketched, having an estimation of the human's functional state (and its implications) at any point in time is a crucial requirement. This requirement is the focus of this paper. To fulfil the requirement, an agent model is proposed that can be used to estimate a human's functional state over time.

The agent model, which was designed in dynamical system style, takes task demand and situational aspects such as noise levels as input and determines internal factors such as the experienced pressure, exhaustion

and motivation, and how they (may) affect task performance. The idea is that such a model can be used in a software environment supporting the human. For example, when it is estimated that the human's functional state may negatively affect task performance, measures can be taken such as alerting the person, or task-reallocation. Moreover, the model can be used to regulate the task load and/or noise level to keep experienced pressure and exhaustion between certain limits thus avoiding negative effects on performance.

In Section 2, the agent model of a functional state is introduced and Section 3 explains the details of the model. The simulations performed with the model are described in Section 4. The model has been verified by a formal analysis (Section 5) and by checking properties of simulation traces (Section 6). Finally, Section 7 discusses the functional state model.

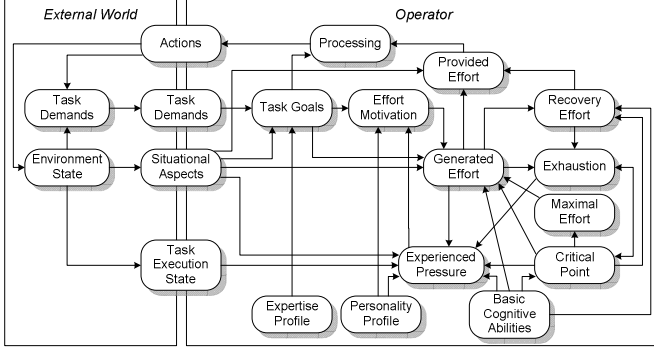
## 2. An Agent Functional State Model

Cognitive workload is a common term in literature on humans working in demanding circumstances; it is known to be influenced by the cognitive demands of a task [4] and personality factors [3]. Cognitive workload is seen as one of many stressors with a negative impact on human performance, like decision making [9], attention [12] and working memory [5]. Examples of other stressors are time pressure, noise and fatigue [9].

In the agent model for the Functional State (FS) of a human, cognitive workload is incorporated as a combination between the task and personal abilities. The FS model is also based on the cognitive energetic framework [7], which states that effort regulation is based on human recourses and determines human performance in dynamic conditions. Furthermore, the model is based on literature concerning exercise and sports [6]. The idea is that a person's generated power can continue on a *critical power* level without becoming more exhausted.

The FS of a human (e.g., an operator in a control room) represents the dynamical state in which the person is situated. In the model presented in Figure 1,

this FS is defined by a combination of exhaustion, motivation and experienced pressure, but also the amount of generated and provided effort. The FS is determined by factors from the external world (task demands and environment state) and by personal factors (experience, cognitive abilities and personality profile). In addition, the FS model shows the relation of this state to a human's actions with respect to the task.



**Figure 1. Agent Model for an Operator's Functional State**

In this model, the concepts *generated effort* and *critical point* are adapted from Hill's concepts generated and critical power [6]. Critical point is the amount of effort someone can generate without becoming exhausted. When exhaustion is 0, the critical point is equal to a human's basic cognitive ability.

Generated effort (the amount of effort the human generates to perform a task) is influenced by the amount of effort the human wants to contribute (*effort motivation*), the amount of effort the human has to contribute (*task level*) and the amount of effort the human is able to contribute (*critical point* and *maximal effort*). When generated effort is below critical point, the human is able to do some recovery (*recovery effort*), which decreases exhaustion. When generated effort is above critical point, this exhaustion is increased. Recovery effort and the effort the human has to contribute to the noise in the environment (*noise effort*) are extracted from the generated effort, which eventually determines the effort that can effectively be contributed to the task (*provided effort*).

The motivation of a person is proportional to the task level, but depends negatively on the *experienced pressure*. Underload is represented by a level of experienced pressure below *optimal experienced pressure* (embedded in *personality profile*) and overload is represented by a level of experienced pressure above optimal experienced pressure. The impact that underload and overload have on motivation are dependent on low and high pressure sensitivities (in personality profile). Experienced pressure itself is increased by high effort (generated effort above critical

point), noise, exhaustion and a performance quality below a personal optimal performance. The factors that have a negative influence on experienced pressure are low effort (generated effort below critical point) and a performance quality above optimal performance.

### 3. The Detailed Model

This section explains the details of the model. There are three *temporal relations*.

$$(1) E(t+\Delta t) = E(t) + Pos(\eta \cdot (GE(t) - CP(t)) \cdot \Delta t) - \pi RE(t) \cdot \Delta t$$

Here Exhaustion ( $E$ ) builds up or reduces over time. When the generated effort ( $GE$ ) is above the critical point ( $CP$ ), exhaustion increases, otherwise exhaustion decreases depending on the level of recovery effort ( $RE$ ). Parameters  $\eta$  and  $\pi$  determine the amount of increase or decrease. The function  $Pos(x)$  in this and other formulas is defined as the maximum of  $x$  and 0.

$$(2) GE(t+\Delta t) = GE(t) + \beta \cdot (CCE(t) - GE(t)) \cdot \Delta t$$

In the temporal relation for generated effort the previous generated effort is taken into account, as well as a current contribution ( $CCE$ ; see formulas (4) and (5) below). Here  $\beta$  is a flexibility parameter; it determines how much of the new generated effort is affected by the current contribution.

$$(3) EP(t+\Delta t) = EP(t) + [\mu 1 \cdot Pos(EPC(t) \cdot (1 - EP(t))) - \mu 2 \cdot Neg(EPC(t) \cdot EP(t))] \cdot \Delta t$$

The temporal relation for experienced pressure ( $EP$ ) is based on the previous experienced pressure and a change value ( $EPC$ ; see (6) below). Parameter  $\mu$  determines the influence of the change value.

Furthermore, the model includes a number of *instantaneous relations*.

$$CCE(t) = NE(t) + \varepsilon \cdot \frac{MaximalEffort(t)}{TopMaximalEffort} \cdot EM(t)$$

$$(4) (w1 \cdot (CP(t) - NE(t)) + w2 \cdot TL(t) + w3 \cdot ME(t))$$

$$(5) TME = LCP + \zeta \cdot (BCA - LCP)$$

The current contribution to generated effort is based on a weighted average of task level ( $TL$ ), critical point and maximal effort ( $ME$ ) multiplied by motivation ( $EM$ ), also noise effort is added ( $NE$ ).  $TME$  represents top maximal effort,  $LCP$  represents lowest critical point and  $BCA$  represents basic cognitive abilities.

$$(6) EPC(t) = ES \cdot E(t) - PS \cdot (PQ(t) - PN) + HES \cdot Pos((GE(t) - CP(t)) / (BCA - LCA)) - LES \cdot Pos((CP(t) - GE(t)) / (BCA - LCA)) + NS (NE(t) / MaxNE(t))$$

This formula, used in (3), consists of five terms mediated by personal sensitivity levels ( $S$ ). The first term is the influence of exhaustion; the second is the influence of the difference between current performance quality ( $PQ$ ) and a personal performance

norm ( $PN$ ). The third and fourth terms represent the influence of generating effort above and below the critical point. The last three terms are first normalized by dividing them by their maximal value.

$$(7) \quad EM(t) = EPI(t) \cdot \left( \frac{1 + \frac{1}{\gamma}}{1 + \gamma \cdot e^{-\phi \cdot TL(t)} - \frac{1}{\gamma}} \right) \cdot \frac{1}{Exp(t)}$$

Effort motivation is calculated using the current task level and the influence of experienced pressure ( $EPI$ ), which is calculated according to (8). Parameters  $\phi$  and  $\gamma$  determine the shape of the sigmoid function.

$$(8) \quad EPI(t) = 1 - (HPS \cdot Pos(EP(t) - OEP) + LPS \cdot Pos(OEP - EP(t)))$$

The effect of experienced pressure ( $EPI$ ) on the effort motivation is determined by the distance between the current experienced pressure and the optimal experienced pressure ( $OEP$ ) multiplied by a personal sensitivity for high ( $HPS$ ) and low pressure ( $LPS$ ).

$$(9) \quad PE(t) = GE(t) - RE(t) - NE(t)$$

Generated effort is the sum of provided effort ( $PE$ ), recovery effort and noise effort. Therefore, to calculate the provided effort, recovery and noise effort are subtracted from generated effort.

$$(10) \quad RE(t) = Pos(\alpha \cdot (CP(t) - GE(t))) \cdot GE(t) \cdot (BCA - CP(t)) / BCA$$

When generated effort is below critical point, effort can be used to lower exhaustion. The amount of effort increases when generated effort is further from critical point (first line of the formula), and increases when the critical point is further from basic cognitive abilities (which is when the human is somewhat exhausted, second line of the formula). Parameter  $\alpha$  represents the efficiency of recovery effort: a small percentage is lost due to inefficiency of the process.

$$(11) \quad CP(t) = LCP + (1 - E(t)) \cdot (BCA - LCP)$$

Critical point is equal to basic cognitive abilities, unless there is some level of exhaustion: then critical point decreases proportionally.

$$(12) \quad ME(t) = LCP + \zeta \cdot (CP(t) - LCP)$$

Maximal effort is  $\zeta$  times critical point or equal to critical point when critical point is equal to the lowest critical point.

$$(13) \quad PQ(t) = PE(t) / TL(t)$$

The quality of performance depends on the relation between provided effort and task level. If provided effort is lower, performance quality is below 1, otherwise above 1.

## 4. Simulation Results

Using the formulas to determine the FS, a large number of simulations have been performed, in which some interesting patterns on human performance have

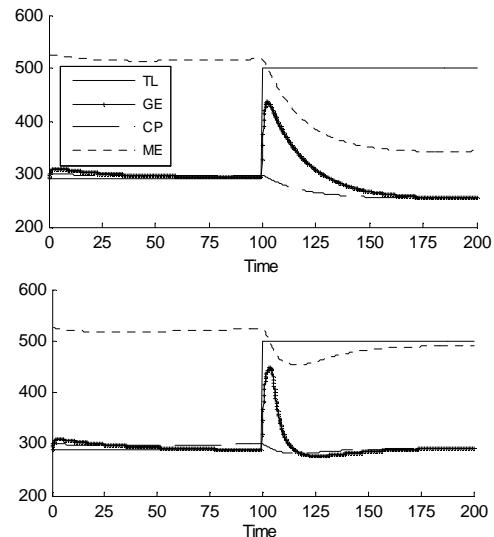
been explored. With variation of the personality factors, some typical patterns can be found. Due to the excessive number of possible combinations, this paper shows example simulation runs for two of the many possible persons with a different personality profile. The Matlab code of the model can be found at <http://www.few.vu.nl/~tbosse/OFS/>.

The duration of the scenario is 200 time points. The task level was 290 for the first half and 500 for the second half. Table 1 outlines the values of the different personality factors used for person 1 and person 2. These settings were found by experimentation.

**Table 1. Personality profiles.**

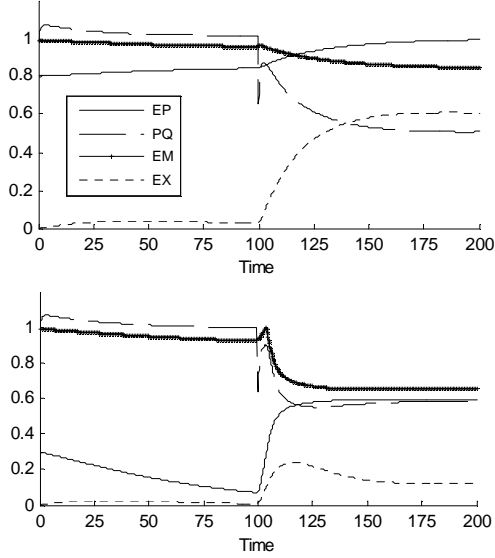
Person 1 (high pq)	Person 2 (low pq)
Experienced pressure change parameters	Experienced pressure change parameters
PN=1.1	PN=0.3
PS=0.5	PS=0.3
ES=0.2	ES=0.7
HES=0.2	HES=0.7
LES=0.7	LES=0.3
NS=0.2	NS=0.6
Experienced pressure influence parameters	Experienced pressure influence parameters
LPS=1.2	LPS=0.8
HPS=0.8	HPS=1.2
OEP=0.8	OEP=0.3

The results of the simulations are shown in Figures 2 and 3. Figure 2a displays the variables with respect to the task: maximal effort (ME), critical point (CP), generated effort (GE) and task level (TL). Figure 3a displays more qualitative variables: performance quality (PQ), effort motivation (EM), experienced pressure (EP) and exhaustion (EX).



**Figure 2 a, b. Effort variables for person 1 (top panel, a) and person 2 (bottom panel, b).**

A comparison of person 1 and 2 for the performance variables shows that when task level is 290, both persons have a more or less equal amount of GE. When task level increases to 500, the GE of both persons increases, but the GE of person 1 decreases more slowly, which induces a reduction of the CP. The CP (and the GE) of person 1 therefore end at a lower level than those of person 2.



**Figure 3a, b. Variables for person 1 (top panel, a) and person 2 (bottom panel, b).**

Figure 3a and b show the mood variables; the main difference at the start of the simulation is EP, as the OEP of person 1 is much higher (0.8) than the OEP of person 2 (0.3). When the task level is increased to 500, person 1's EX increases, due to the large amount of time at which person 1's generated effort is above the critical point (see Figure 2a). The motivation of person 2 decreases when task level is increased to 500, which is caused by EP being much higher than OEP. Person 1 also has a high EP; however, this value is close to the OEP so there is no negative effect on motivation.

## 5. Formal Analysis

By a mathematical formal analysis the equilibria can be determined, i.e., the values for the variables for which no change occurs. Note that to this end the exogenous variables *TaskLevel* and *NoiseEffort* are assumed to have a constant value, denoted by *TL*, resp. *NE*. To obtain possible equilibrium values for the other variables, first the model is described in a differential equation form:

- (1)  $dExhaustion(t)/dt = Pos(\eta(GeneratedEffort(t) - CriticalPoint(t))) - \pi RecoveryEffort(t)$
- (2)  $dGeneratedEffort(t)/dt = \beta(CurrentContributionEffort(t) - GeneratedEffort(t))$

- (3)  $dExperiencedPressure(t)/dt = \mu1 Pos(ExperiencedPressureChange(t)) \cdot (1 - ExperiencedPressure(t)) - \mu2 Neg(ExperiencedPressureChange(t)) \cdot ExperiencedPressure(t)$

Next, the equations are identified describing

- (1)  $dExhaustion(t)/dt = 0$
- (2)  $dGeneratedEffort(t)/dt = 0$
- (3)  $dExperiencedPressure(t)/dt = 0$

Thus the following equations are found:

- (1)  $GE = CP$  and  $RE = 0$
- (2)  $CCE = GE$
- (3)  $[EP > 0$  and  $EP < 1$  and  $EPC = 0]$  or  $[EP = 0$  and  $EPC \leq 0]$  or  $[EP = 1$  and  $EPC \geq 0]$

Here *GE* is the (equilibrium) value for *GeneratedEffort*, *CP* for *CriticalPoint*, *RE* for *RecoveryEffort*, *CCE* for *CurrentContributionEffort*, *EP* for *ExperiencedPressure*, and *EPC* for *ExperiencedPressureChange*. Similar notations are used for the other equilibrium values. Here a first set of conclusions is that an equilibrium can only occur when the generated effort equals the critical point, no recovery takes place, and the current contribution effort is equal to generated effort. Elaborating the equations further can be done by distinguishing cases according to (3). The first case considered is  $EPC = 0$ . For this case it can be derived that the values for the equilibria can be calculated by the following formulae:

$$E = [PeS \cdot (BCA - NE - PN \cdot TL) / TL - NoS \cdot NE / MNE] / [ExS + PeS \cdot (BCA - LCP)]$$

$$GE = CP = LCP + (1 - E) \cdot (BCA - LCP)$$

$$PE = GE - NE$$

$$EM = (CP - NE) \cdot (LCP + \zeta \cdot (BCA - LCP)) / \varepsilon \cdot (LCP + \zeta \cdot (CP - LCP)) \cdot (w1 \cdot (CP - NE) + w2 \cdot TL + w3 \cdot (LCP + \zeta \cdot (CP - LCP)))$$

$$EP = OEP + (1 - EM \cdot Expect / \logist(TL)) / HpS$$

or

$$EP = OEP - (1 - EM \cdot Expect / \logist(TL)) / LpS$$

Similarly, formulae can be derived for the other two cases in (3), namely  $EP = 0$  or  $EP = 1$ .

## 6. Automated Verification

This section addresses analysis of the agent model by verification of dynamic properties. Following [1], the dynamics of a simulation model can be studied by specifying certain dynamic statements (temporal logical expressions), that are (or are not) expected to hold and automatically verifying these statements against simulation traces. The purpose of this type of verification is to check whether the simulation model behaves as it should. A typical example of a property that may be checked is whether no unexpected situations occur, such as a variable running out of its bounds (e.g.,  $Exhaustion < 0$ , or  $GeneratedEffort >$

MaximalEffort). By running a large number of simulations and verifying such properties against the resulting simulation traces, the modeler can easily locate sources of errors.

For the model of the human's functional state, a number of such dynamic properties have been formalized in the language TTL [1]. This predicate logical language supports formal specification and analysis of dynamic properties, covering both qualitative and quantitative aspects. TTL is built on atoms referring to *states* of the world, *time points* and *traces*, i.e. trajectories of states over time. In addition, *dynamic properties* are temporal statements that can be formulated with respect to traces based on the state ontology Ont in the following manner. Given a trace  $\gamma$  over state ontology Ont, the state in  $\gamma$  at time point  $t$  is denoted by  $\text{state}(\gamma, t)$ . These states can be related to state properties via the formally defined satisfaction relation denoted by the infix predicate  $\models$ , comparable to the Holds-predicate in the Situation Calculus:  $\text{state}(\gamma, t) \models p$  denotes that state property  $p$  holds in trace  $\gamma$  at time  $t$ . Based on these statements, dynamic properties can be formulated in a formal manner in a sorted first-order predicate logic, using quantifiers over time and traces and the usual first-order logical connectives such as  $\neg$ ,  $\wedge$ ,  $\vee$ ,  $\Rightarrow$ ,  $\forall$ ,  $\exists$ . A special software environment has been developed for TTL, featuring both a Property Editor for building and editing TTL properties and a Checking Tool that enables formal verification of such properties against a set of (simulated or empirical) traces.

Various dynamic properties for the model have been formalized in TTL. Below, a number of them are introduced, both in semi-formal and in informal notation (note that they are all defined for a particular trace and time interval between  $t_b$  and  $t_e$ ):

#### P1 - Stability of Variable v

For all time points  $t_1$  and  $t_2$  between  $t_b$  and  $t_e$  in trace  $\gamma$   
if at  $t_1$  the value of  $v$  is  $x_1$   
then at  $t_2$  the value of  $v$  is between  $x - \alpha$  and  $x + \alpha$   
(where  $\alpha$  is a constant).

$$\begin{aligned} P1(\gamma:\text{TRACE}, t_b, t_e:\text{TIME}, v:\text{VAR}) \equiv \\ \forall t_1, t_2:\text{TIME } x_1, x_2:\text{REAL} \\ \text{state}(\gamma, t_1) \models \text{has\_value}(v, x_1) \ \& \\ \text{state}(\gamma, t_2) \models \text{has\_value}(v, x_2) \ \& \\ t_b \leq t_1 \leq t_e \ \& \ t_b \leq t_2 \leq t_e \Rightarrow x_1 - \alpha \leq x_2 \leq x_1 + \alpha \end{aligned}$$

This property can be used to verify in which situations a certain variable does not fluctuate much. It has been found, for example, that for the two traces shown in Section 4 and for  $\alpha=1.0$ , the Critical Point remains stable between time point 450 and 500. In other words, checking  $P1(\text{trace}, 450, 500, \text{CP})$  was successful, where trace is one of the traces of Section 4, i.e. either trace1 (corresponding to person 1, i.e., the

perfectionist) or trace2 (corresponding to person 2, the non-perfectionist).

#### P2 - Monotonic Decrease of Variable v

For all time points  $t_1$  and  $t_2$  between  $t_b$  and  $t_e$  in trace  $\gamma$   
if at  $t_1$  the value of  $v$  is  $x_1$  and at  $t_2$  the value of  $v$  is  $x_2$   
and  $t_1 < t_2$ , then  $x_1 \geq x_2$ .

$$\begin{aligned} P2(\gamma:\text{TRACE}, t_b, t_e:\text{TIME}, v:\text{VAR}) \equiv \\ \forall t_1, t_2:\text{TIME } x_1, x_2:\text{REAL} \\ \text{state}(\gamma, t_1) \models \text{has\_value}(v, x_1) \ \& \\ \text{state}(\gamma, t_2) \models \text{has\_value}(v, x_2) \ \& \\ t_b \leq t_1 \leq t_e \ \& \ t_b \leq t_2 \leq t_e \ \& \ t_1 < t_2 \Rightarrow x_1 \geq x_2^1 \end{aligned}$$

Property P2 can be used to check whether a variable decreases monotonically over a certain interval. For example, the Experienced Pressure turned out to decrease over the first half of the trace of person 2 (i.e., property  $P2(\text{trace2}, 1, 250, \text{EP})$  succeeded).

#### P3 - Variable v Approaches Value x with Speed s

For all time points  $t_1$  and  $t_2$  between  $t_b$  and  $t_e$  in trace  $\gamma$   
if at  $t_1$  the value of  $v$  is  $x_1$  and at  $t_2$  the value of  $v$  is  $x_2$   
and  $t_2 = t_1 + 1$ , then  $s * |x - x_1| \geq |x - x_2|$  (where  $s$  is a constant).

$$\begin{aligned} P3(\gamma:\text{TRACE}, t_b, t_e:\text{TIME}, v:\text{VAR}, x:\text{REAL}) \equiv \\ \forall t_1, t_2:\text{TIME } x_1, x_2:\text{REAL} \\ \text{state}(\gamma, t_1) \models \text{has\_value}(v, x_1) \ \& \\ \text{state}(\gamma, t_2) \models \text{has\_value}(v, x_2) \ \& \\ t_b \leq t_1 \leq t_e \ \& \ t_b \leq t_2 \leq t_e \ \& \ t_2 = t_1 + 1 \Rightarrow s * |x - x_1| \geq |x - x_2| \end{aligned}$$

By checking property P3, one can check whether a variable eventually approaches a certain (given) value, and with which speed  $s$  this happens (where  $0 < s < 1$ , and a high  $s$  denotes a slow speed). This can be used, among others, to check in which situations the system ends up in one of the equilibrium values calculated in Section 5. For example, for the generated traces, the case where the  $EPC = 0$  (described in Section 5) can be confirmed for the end of the simulation: property  $P3(\text{trace}, 475, 500, \text{EPC}, 0.0)$  succeeded for those traces. The speed  $s$  turned out to be 0.96904 for trace1 and 0.99997 for trace2.

#### P4 - Higher variable v1 (in m1) leads to lower variable v2

If in trace  $\gamma_1$  at  $t_b$  the value of  $v_1$  is  $x_1$   
and in trace  $\gamma_2$  at  $t_b$  the value of  $v_1$  is  $x_2$   
and in trace  $\gamma_1$  at  $t_e$  the value of  $v_2$  is  $y_1$   
and in trace  $\gamma_2$  at  $t_e$  the value of  $v_2$  is  $y_2$   
then if  $x_1 \geq x_2$ ,  $y_1 \leq y_2$  and if  $x_1 \leq x_2$ ,  $y_1 \geq y_2$

$$\begin{aligned} P4(\gamma_1, \gamma_2:\text{TRACE}, t_b, t_e:\text{TIME}, v_1, v_2:\text{VAR}) \equiv \\ \forall x_1, x_2, y_1, y_2:\text{REAL} \\ \text{state}(\gamma_1, t_b) \models \text{has\_value}(v_1, x_1) \ \& \\ \text{state}(\gamma_2, t_b) \models \text{has\_value}(v_1, x_2) \ \& \\ \text{state}(\gamma_1, t_e) \models \text{has\_value}(v_2, y_1) \ \& \\ \text{state}(\gamma_2, t_e) \models \text{has\_value}(v_2, y_2) \ \& \\ \Rightarrow [x_1 \geq x_2 \Rightarrow y_1 \leq y_2] \ \& \ [x_1 \leq x_2 \Rightarrow y_1 \geq y_2] \end{aligned}$$

This property can be used to determine how variables influence each other. A specific variant of the

<sup>1</sup> Note that a stronger variant of this (and similar) properties can be created by replacing  $\geq$  by  $>$ .

property is P4(trace1, trace2, 1, 500, OEP, CP), which checks whether persons with a high Optimal Experienced Pressure (i.e., perfectionists, those that try to work much under stress) eventually end up with a lower Critical Point than those with a lower OEP, given the same circumstances. This property was satisfied for all of the generated traces (i.e., for the traces shown in Section 4, but also for a large number of other traces under various parameter settings).

## 7. Discussion

In order to develop an intelligent agent system that supports humans in demanding circumstances, an (agent) model is required that describes the dynamics of a human's functional state in relation to task performance and the environment. To this end, this paper presented such a model, which was developed in dynamical system style. The model takes task demand and situational aspects as input and determines internal factors such as the experienced pressure, exhaustion and motivation. Using Matlab, a large number of simulation experiments under different parameter settings have been performed. Although an extensive empirical validation is left for future work, these experiments pointed out that the model is able to produce behaviour of different types of personalities. Moreover, by a mathematical analysis the equilibria of the model have been determined, and a number of expected properties of the model have been verified. For example, these checks pointed out that all variables stayed within their boundaries, and the calculated equilibria are confirmed. In addition, the specific hypothesis that persons with a high OEP eventually end up with a lower CP was confirmed.

Although a number of other approaches in the literature address various aspects of stress, exhaustion, or situation awareness separately [2], [8], [11], we are not aware of any attempts to combine all these aspects together in as much detail as the current approach.

In future work more attention will be paid to the model's external validation. The mathematical and automated analyses described above have been successfully performed to guarantee internal validity, but this does not guarantee that the model is directly applicable to real humans, and in particular which personality parameter values fit to which person. Therefore, as a next step, validation of the model in laboratory experiments is planned. The idea is to offer a human certain demanding tasks, measure its performance and several physiological data, feed these data into the model, and compare the output of the model with self-reports of the participants (similar to [10]). This will not only provide validation of the

model, but also realistic parameter settings for different types of individuals.

## 8. References

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