Exam Behavioural Dynamics 2010 (December 20, 2010, 15:15 – 18:00).

Assignment 1 (40 pts)

In this assignment the following case is analysed:

Reporting of safety occurrences by air traffic controllers is an important activity in air traffic organisations. Examples of safety occurrences are: 'an aircraft starts moving due to miscommunication between a controller and the pilots', 'the distance between two aircraft is less than a predefined threshold'. Safety occurrence reporting enables identification of complex safety-related problems in an air traffic organisation, and thus, enhances the overall organisational safety. In this assignment you will model a simplified decision making process of an air traffic controller represented by agent Tim, who decides whether to report an observed safety occurrence.

If Tim observes occurrence OC of type OT, and Tim has not observed before that a controller agent received a reprimand for reporting an occurrence of type OT, then Tim will desire to report OC. Furthermore, Tim will desire to report any occurrence, in which he is involved, after Tim observed that another agent saw this occurrence.
If Tim desires to report an occurrence and observes a suitable formal procedure for this occurrence, then Tim will intend to report the observed occurrence. Tim's intention to report is realised in the end of the shift, when Tim creates a notification report about the observed occurrence.

Assume that generation of each cognitive state takes time, which you can choose yourself. Furthermore, assume the following relevant state properties in your model:

External state properties

occurred(OC, OT)	Safety Occurrence OC of type OT happened, in which Tim is involved
reprim_for(OT)	A reprimand for reporting of an occurrence of type OT is provided to a controller agent
is_seen_by(OC, a)	Tim's occurrence OC is seen by another agent a
proc_for(OC)	A formal procedure exists suitable for reporting OC
shift_is_finished	Tim's shift is finished
is_reported_by(OC, Tim)	OC is reported by Tim

Input state properties

obs(occurred(OC, OT))	Tim observed that occurrence OC of type OT happened, in which he is involved
obs(reprim_for(OT))	Tim observed that a reprimand for reporting of an occurrence of type OT was provided to a controller agent
obs(is_seen_by(OC, a))	Tim observed that occurrence OC was seen by agent a
obs(proc_for(OC))	Tim observed that a formal procedure suitable for reporting OC exists
obs(shift_is_finished)	Tim observed the end of his shift

Output state properties

performed(report(OC))	Tim reported OC

Internal state properties

belief(occurred(OC, OT))	Tim believes that occurrence OC of type OT happened, in which he is involved
belief(reprim_for(OT))	Tim believes that a reprimand for reporting of an occurrence of type OT was provided to a controller agent
belief(is_seen_by(OC, a))	Tim believes that occurrence OC was seen by agent a
belief(proc_for(OC))	Tim believes that a formal procedure exists suitable for reporting OC
belief(shift_is_finished)	Tim believes that his shift is finished
d	Tim desires to report OC
i	Tim intends to report OC

a) Show the dynamics of the example in graphical form. Do not forget to indicate which state properties are persistent. **(8)**

b) Write down at least 3 executable dynamic properties in the semi-formal form that characterise these dynamics. **(7)**

c) For the properties you defined in b), indicate which ones are *step properties* and which ones are *persistence properties*. **(4)**

d) If possible, give the representational content of internal state property d (Tim desires to report OC) according to the externalist causal/correlational approach. Look both backward and forward. **(6)**

e) Name the classical problems with the externalist causal/correlational approach. For each problem explain whether it occurs in d). **(7)**

f) If possible, give the representational content of internal state property i (Tim intends to report OC) according to the second-order relational specification approach. Do not forget to look backward and forward. **(8)**

Assignment 2 (20 pts)

Between working shifts air traffic controllers have breaks. During breaks controllers often discuss safety occurrences observed during their shifts. Based on such discussions, controllers may discover safety-related problems, worth to be reported to the management. These dynamics can be modelled by a multi-agent system.

Imagine a multi-agent system, in which two controller agents, Bob and Dan, discuss regularly observed occurrences. When both agents have gathered sufficient experience about occurrences of some type, they report a safety problem underlying these occurrences to manager agent Trever.

The following properties describe some aspects of these dynamics at different aggregation levels:

P1: There exist a trace of the system and a time point, at which manager Trever receives a notification about a safety problem from the controller agents.

P2: For any trace and for any time point if Bob receives information about a safety occurrence, then at a later time point Bob will create the corresponding belief based on this information.

P3: For any trace and for any time point if both Bob and Dan possess information about more than five safety occurrences of the same type, then at a later time point manager Trever will receive a notification about a safety problem from the controller agents.

P4: For any trace and for any time point if Dan has a belief about a safety occurrence, then this belief will also hold at the next time point.

g) In your opinion, which from the properties **P1-P4** can be considered as local, intermediate and global dynamic properties? Please, motivate your answer. **(8)**

h) Suppose that **P1** is not satisfied. How would you use the compositional analysis method to identify the cause of failure of this property in the context of this multi-agent system? **(12)**

Assignment 3 (40 pts)

The formal layer of a human organisation comprises a set of rules, norms, and regulations imposed on the organisational actors. The formal layer prescribes a significant part of the activities performed in real large-scale organisations. However, organisational actors still have autonomy to decide, to which extent to follow the prescriptions of the formal layer. Thus, the actual organisational dynamics emerges from an interaction between the formal layer and the variability of autonomous behaviour of the organisational actors, which may be represented by agents. The variability of agent behaviour can be specified by cognitive models, similar to the ones considered in Assignment 1. The AGR framework can be used to describe functionalities and interactions of the formal organisational layer.

In this assignment, a partial description of the formal layer of an air traffic organisation related to safety occurrence reporting is considered:

When an air traffic controller observes a safety occurrence, s/he creates a notification report about this occurrence. This report is provided by the controller to the safety manager from the safety investigation department. The safety manager assigns a safety investigator from his/her department to perform the investigation of the report. Also, an external investigator is requested by the safety manager to examine the occurrence notification report. After both the internal and external safety investigators finished the investigation, they discuss the investigation results. Based on this discussion, the internal investigator creates an interim investigation report, which is provided by the internal investigator to the safety manager. The safety manager revises the interim report and provides the final investigation report to the controller, who created the notification report.

In this exercise you need to model this description using the AGR framework.

a) Express the AGR-specification of this organisation in **graphical** format. (**14**)

b) Express the behaviour of the organisation in terms of semi-formal dynamic properties. Try to limit yourself to the behaviour described in the text above. (**14**)

c) Provide a proof tree for the organisational property *"if an air traffic controller provides a notification report about a safety occurrence to the safety manager, then the air traffic controller will eventually receive the final investigation report based on his/her notification report"* (**12**)