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Simulation Based Decision Processes for Territorial Security

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Abstract

Planning for regional security and crisis management is identified as a multi layered system. Delays, however, have manifested themselves as a common property of such systems. This means that an action on one level will cause surprising impacts on the others, but first after some retardation. Fortunately, with help of anticipatory modelling and computer simulation it is possible to demonstrate the effects of those complex inter level interactions. As an example, it is found that longer delays tend to increase the instability of the system, with great fluctuations as a consequence. An anticipation factor, however, may help to counteract those fluctuations.

Keywords: Multi Layered Systems, Simulation, Geographical Regions, Security, Decision Making.

1. Introduction

As manifested in the European FP7 research program1, Security has lately become a main issue in European Research and Technical Development (RTD). This broad area includes, among many other topics, research on simulation, planning, and training for management of crisis and complex emergencies in and between geographical regions. The rationale for that focus may be found in current research. In short, those results indicate that the outcome of any complex emergency situation to a large extent is due to the preparations and trainings done before the crisis or disaster outbreak (Bolin and 'tHart, 2007).

The research up to this date, however, has not fully realised that planning and preparation for emergency protection is a multidimensional endeavour with complex and intrinsic interdependencies between different levels of attention. The purpose of this paper, hence, will be to increase the understanding of complexity issues in relation to territorial security planning.

The solution approach that we propose in this paper applies systems thinking and a multi modal system design methodology in combination with an anticipatory modelling and simulation approach. All this is in order to solve a practical operational planning problem. Our approach will integrate research insights from both social and engineering (technological) sciences.

2 The Regional Security Context

The Territorial Concern (TC) may be taken as a base concept for discussing regional and interregional security. A TC, as outlined in figure 1, being a community based organisation for the design, construction, and maintenance of order and security within a geographicala territory or region (a space). In other words, a TC is a homeostatic system, with the responsibility (the

[1] http://cordis.europa.eu/fp7/dc/index.cfm (2010-03-10)

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concern) to establish and maintain a satisfactory configuration of system components and processes and to keep a set of essential variables within critical levels (Holmberg, 1998).

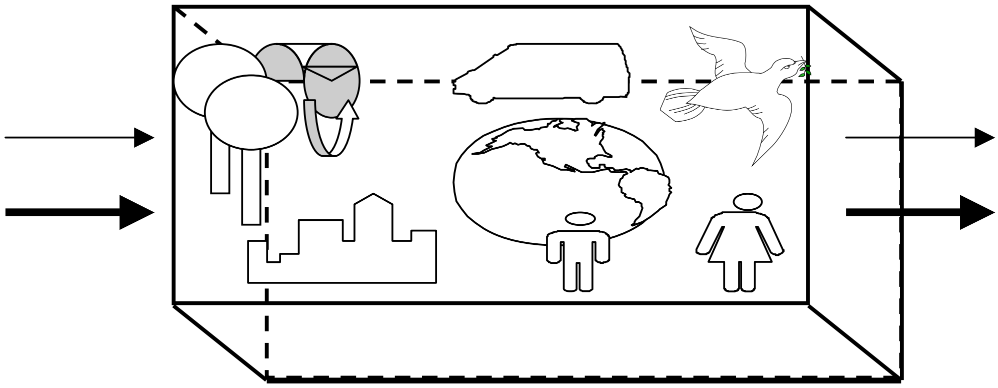

Figure 1. A territorial concern (TC) with flows, processes, and living and non-living inhabitants.

Coming to planning and decision making for security and crisis management within a TC a multi layered system will emerge. First, on the lowest operational level there are direct rescue work aiming at the re establishment of a threatened order. On the next tactical level we find maintenance actions with the purpose to keep security equipment and procedures in good form. On the highest strategic level, at last, there are measures for creating and building an as secure environment as possible. An environment there crisis and accidents never will happen. The security management within a TC, however, is heavily complicated by delays and interdependencies between levels. This means that an action on one level will have an impact on the others, but first after some retardation.

Building on earlier more general work by Dubois and Holmberg (2006, 2008) anticipatory modelling and simulation will here be applied as a tool for understanding and handling those challenges to the management of TC security. A solid argument for this approach is Ackoff 's (1981) statement that "*The future is largely subject to creation*", and "*the future depends at least as much on what we and others like us do between now and then as it does on what happened until now*". By this we deduce that it is necessary to develop a model (design) of the desired future and to take measures (actions) in order do attain that desired future, i.e. the design target. In terms of anticipation, this is exactly the same as prescriptive anticipation (PA) according to Holmberg (2002). Anticipation, with other words, is here interpreted according to the etymology of the word, which implies doing or acting in advance.

3. Anticipatory Model of Regional Security Preparations

A simplified model of the TC security is given in fig. 2. The state at the operational level is given by the temporal function R(t), which may represent the direct rescue work in the TC. The next tactical level is represented by the function P(t), which stands for preparations and training for security and rescue missions. The function C(t), at last, represents creation of new security structures and processes at the strategic level. The effect of delays is shown by the relation between $P(t-\tau r)$ and R(t), i.e. preparations on an earlier moment will have a delayed effect on later rescue work. Anticipation works in a similar way. The rescue (R) that is set as a target for time $t+\tau a$ will determine the necessary creation (C) at time t.

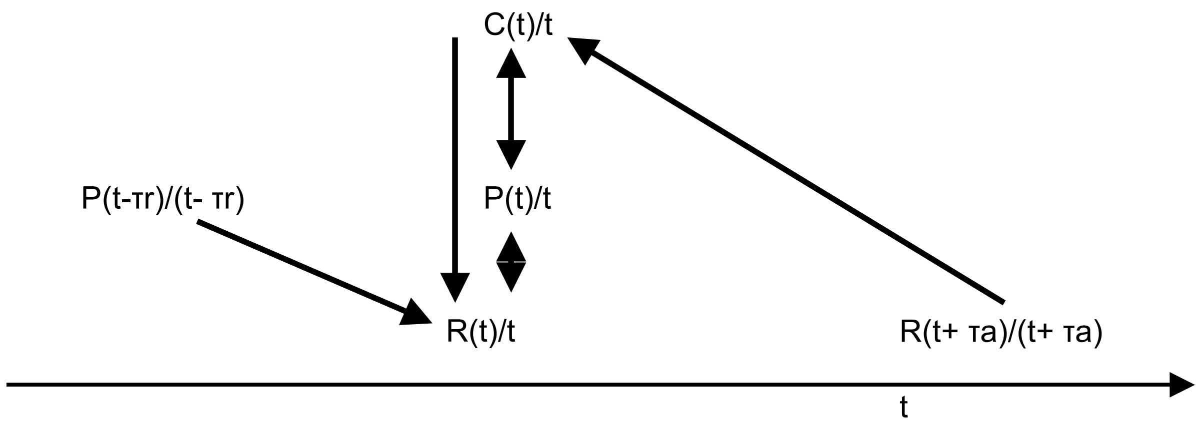

Figure 2: Basic interdependencies of retardation and anticipation in TC security.

Following the approach of Dubois and Holmberg (2006) the graphical model in fig. 2 can, for example, be developed into the following set of difference equations.

$$R(t+1) = R(t) + dt[cR(t)P(t-\tau) + eR(t)C(t) - dR(t)] \quad (1)$$

$$P(t+1) = P(t) + dt[f + bP(t)C(t) - cP(t)R(t)] \quad (2)$$

$$C(t+1) = C(t) + dt[aC(t) - bC(t)P(t) - eC(t)R(t)] \quad ..$$

$$-e(ant)C(t)(R(t+1) - R(t)) \quad ..$$

$$-[e(ant^2)/2dt](C(t)(R(t+1) - 2R(t) + R(t-1)) \quad (3)$$

Further, the qualitative behaviour of a TC security system may be simulated by applying eqs. 1-3 in a computer model. In so doing it is found that longer delays (τ) tend to increase the instability of the system, with greater fluctuations as a consequence. An anticipation factor (ant), though, may help to counteract those negative effects.

4. Simulations for Learning

The solution derived from eqs. 1-3 was implemented as a computer based simulation tool[2] called simTC. In this context, by synthesising the modelling paradigms of van Gigch [11], le Moigne [12] and

[2] http://www.c8systems.com/simtc (with Mozilla Firefox browser)

others it is found that modelling and simulation is an ongoing and never ending learning process according to fig. 3. The model may here not be conceptualised as a static tool but more as a dynamic representation of our current understanding of the situation or entity under study. Hence, simTC should be implemented in a way that makes it possible for the user to (re)model, simulate, anticipate, and reflect in a direct and interactive manner. According to Klir (13], relevance and simplicity are here more important properties than realism and fitness to real data. In that spirit, simTC is to serve as a continuous learning tool in the TC security work..

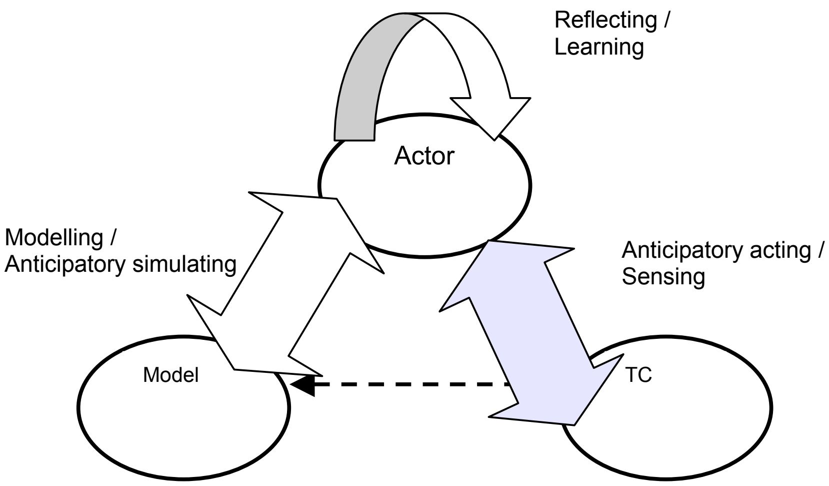

Figure 3: Modelling and simulation as an ongoing learning process.

By experimenting with different sets of values for parameters a – f and initial values for R_0, P_0, and C_0 respectively, very complex and surprising patterns may emerge (Dubois and Holmberg, 2006). The essential step here, however, is to create concrete associations between the entities in the formal model and the corresponding concrete actions and processes in the real world of the TC (Warfield, 2002). First when those associations are firmly established the model will be of any value for the TC security managers and decision makers.
In the TC security case, for example, there may rescue actions in cooperation between different security units, common training exercises for all security officers in the TC or a broad set of accident prevention actions. Hence, once the necessary associations between the TC and the model are identified, the model can help decision makers to find the best mix of actions on operational, tactical and strategic levels (Asproth et al., 2010).

5. Conclusion

Seen in the light of de Raadt's (2002) Multimodal Systems Model (MMSM) with fifteen levels and relationships in both directions between all levels, the modelling approach presented here may seem too simplistic. However, already with this simple model some important properties of regional security systems can be demonstrated. Simulations with this model have for example demonstrated that:

- Regional security is not just rescue work. Preparations and training, as well as strategic measures, have a great impact on the total security level in the TC in focus.

- Anticipation is important in order to counteract the negative effects of delays in this type of multi layered complex systems.

- The realism and truthfulness of the model, however, will be of crucial importance in order to get it accepted by the regional security decision makers. Hence, great effort has to be put into the work of capturing scenarios and events from the real world and incorporating them into the simulation tool.

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