

Aviation Accident Investigation and ATM Automation Risk Assessment using the Functional Resonance Accident Model

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Preliminary results and challenges, FRAM workshop, Sophia-Antipolis, 080220

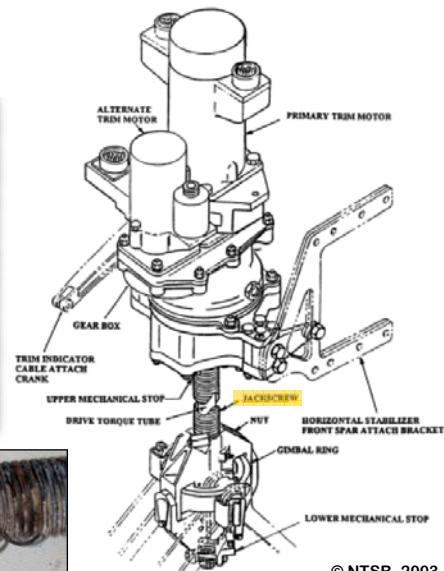
Research Endeavor

Functional Resonance Accident Model (FRAM) as a modeling method
for analysis of complex socio-technical systems

- *Aviation accident analysis*
 - Alaska Airlines flight 261, Comair 5191, Norwegian 541
- *Air traffic control risk assessment*
 - ERASMUS-automation in future air traffic control systems
- *Analysis of team work in command and control*
 - Command and control (emergency management and military) simulations



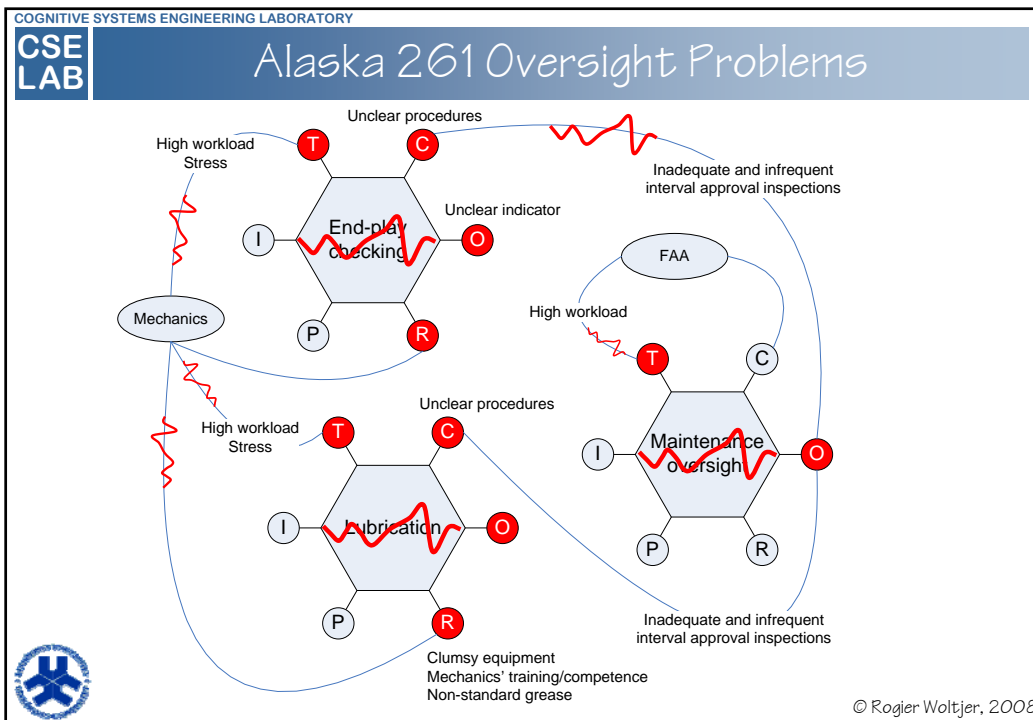
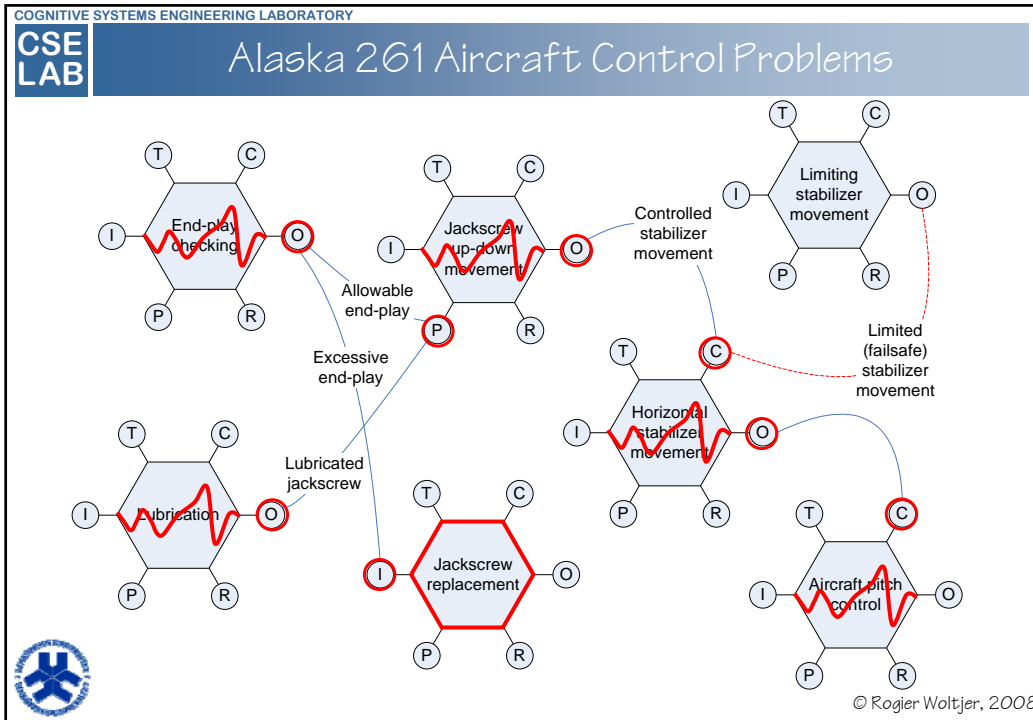
Alaska Airlines 261: Horizontal Stabilizer



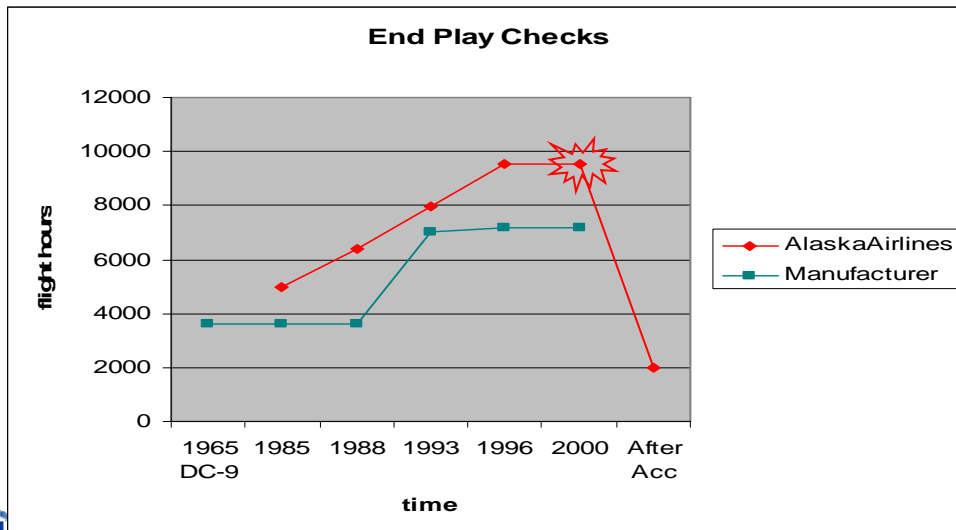
FRAM Steps in Analysis

- 0** Define the purpose of modelling (risk assessment) and describe the target situation or scenario to be analysed.
- 1** Identify essential system functions; characterise each function by six basic parameters.
- 2** Characterise the (context dependent) potential variability using a checklist. Consider both normal and worst case variability.
- 3** Define functional resonance based on possible dependencies (couplings) among functions.
- 4** Identify barriers for variability (damping factors) and specify required performance monitoring.





Decreasing End Play Checks



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Alaska Airlines 261 FRAM Challenges

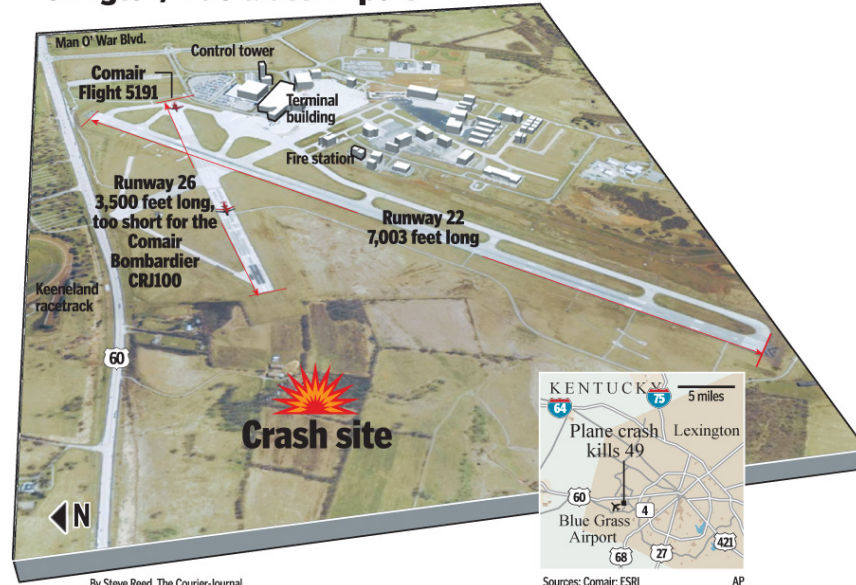
- FRAM version of "drift into failure"?
- Functional modeling of organizational factors
- Modeling of factors that are performed over long time periods
- (How) can one model "whistle-blowers"? Do we want to?



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Comair 5191 Lexington Accident

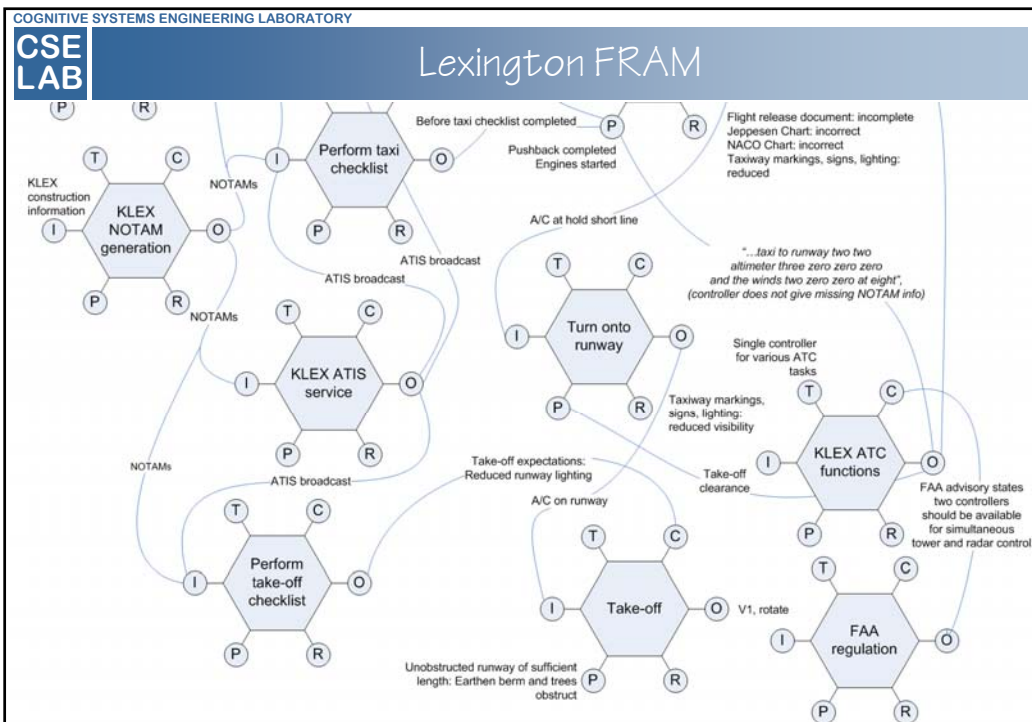
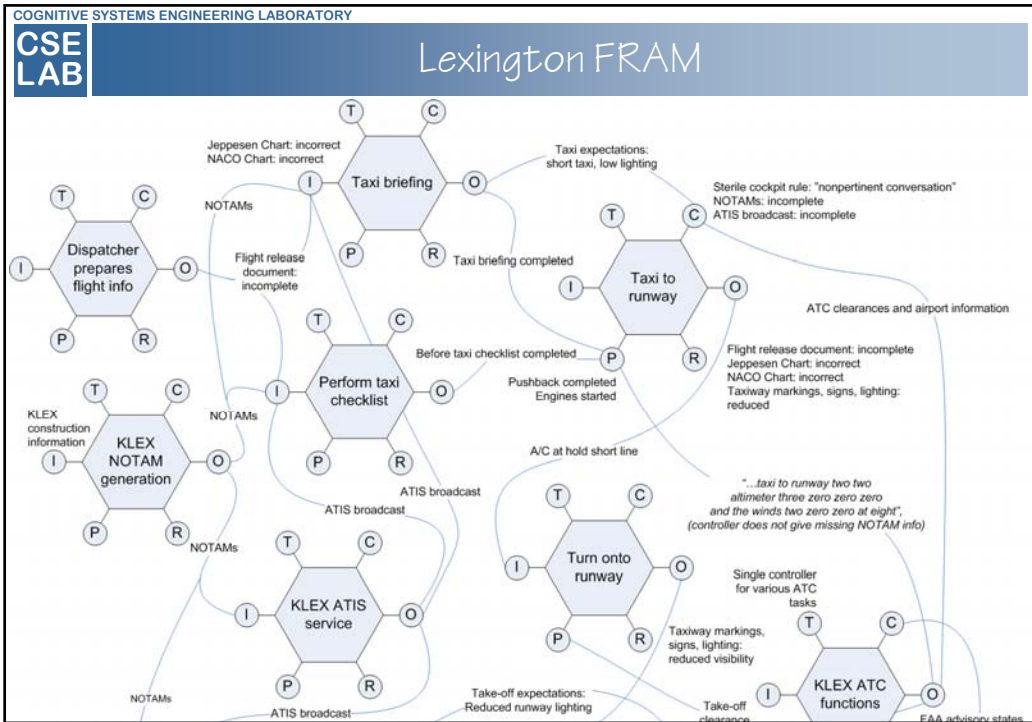
Lexington/Blue Grass Airport

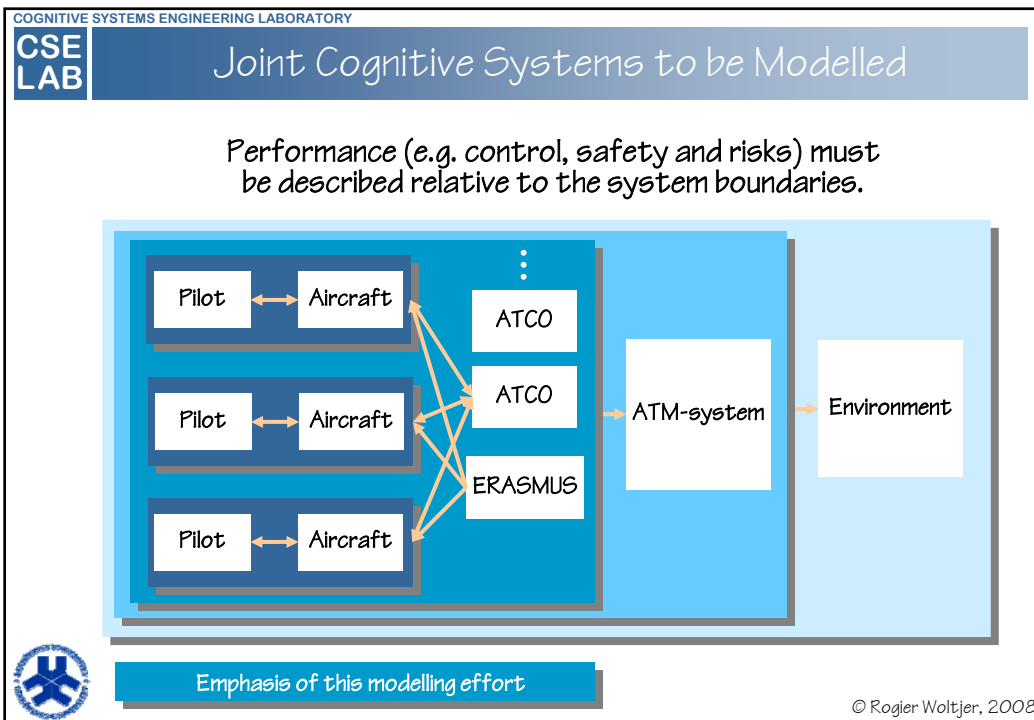
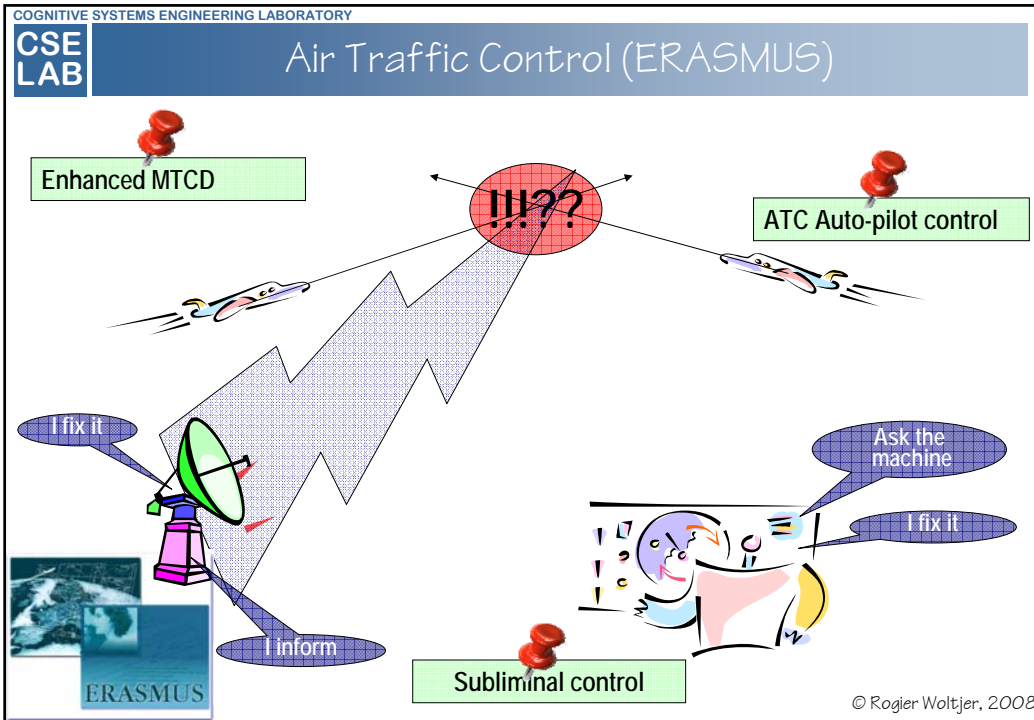


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Steps in Analysis, Current Focus Highlighted

- 0** Define the purpose of modelling (risk assessment) and describe the target situation or scenario to be analysed.
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Identifying Functions

Methods and techniques to identify functions:

Procedures, named individual functions

Work descriptions

Design case, use case, scenario

Task analysis, for instance Hierarchical Task Analysis (HTA)

Functional decomposition, functional analysis, Goals-Means Task Analysis

When using an existing method, throw away all the 'lines' in the results, but keep the names of functions or activities.

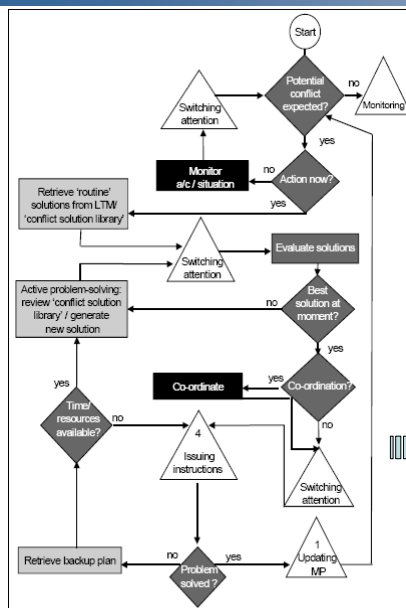
There is no single or elementary level of description. Functions can be described on different levels.

If there can be significant variability in a function, then develop the description / analysis further! Go beyond system boundaries if needed.



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- Make an inventory of task analyses of en-route ATC
- Select a subset of core functions identified in these analyses
- Take these core functions as an input to the FRAM model
- Let the FRAM method (& tool) identify links between functions
- **Result 1: a FRAM model of en-route ATC**
- Identify the functions that are affected by the ERASMUS appl's
- Take this information as input to the model and identify how the model (links) changes by including ERASMUS functionality
- **Result 2: for each ERASMUS application the FRAM model/links must be reassessed.**
- **Result 3: a systematic evaluation of ERASMUS consequences**



Functions derived:

- Conflict search and monitoring
- Determine action urgency
- Situation-solution recognition/generation
- Mental simulation
- Implement solution

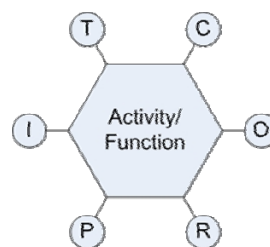
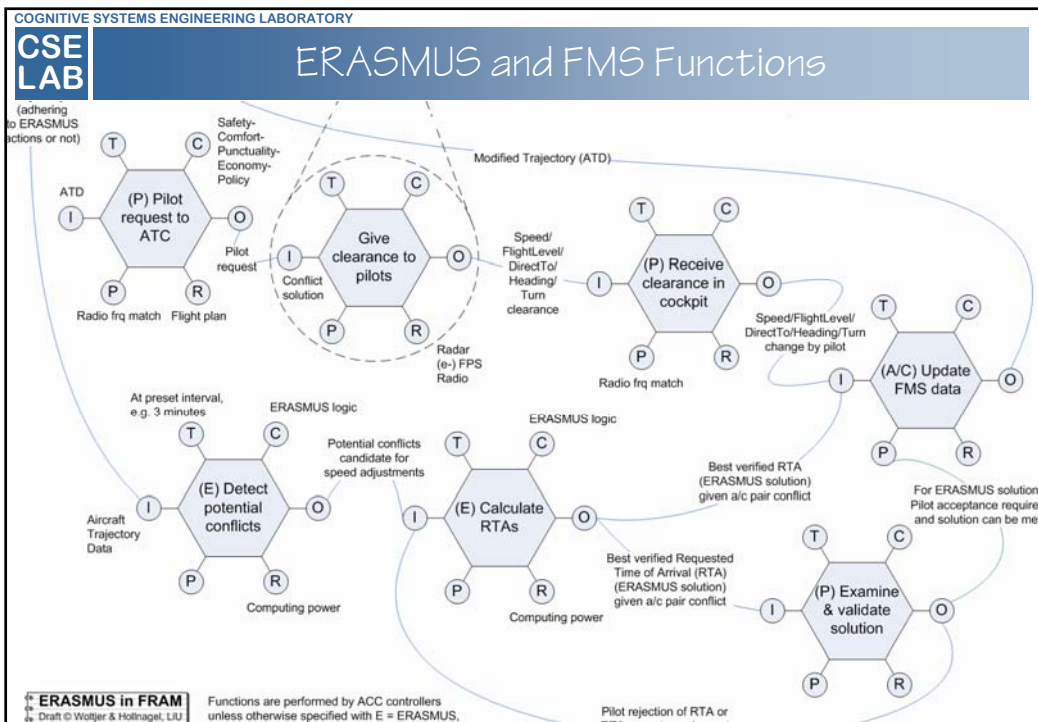
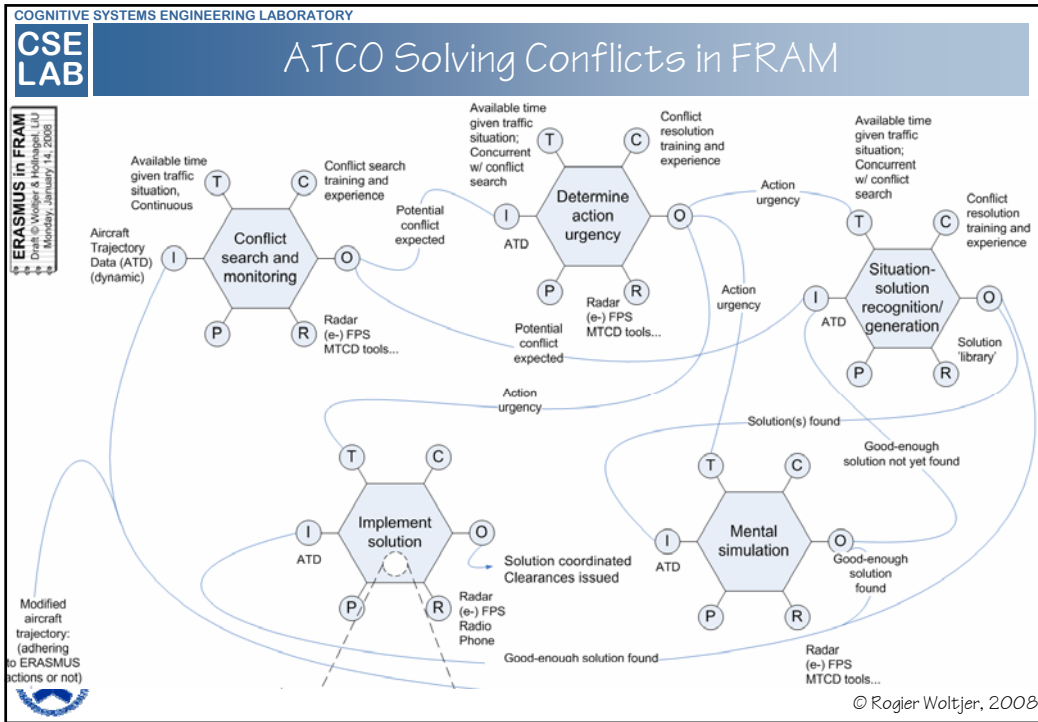


Figure 11: Task process 5: solving conflicts



Challenges ERASMUS ATC Modelling

- Task analyses may be used to establish a FRAM model
- Given a functional model, we may specify how functions are affected when the joint cognitive system is changed, for example when conflicts are solved jointly by ATCOs and ERASMUS
- FRAM models functions and their performance, not steps of cognitive processes, but how to model "cognitive functions" and their variability with FRAM? Minimal models?
- Use of functions "simplifies" model, makes it less sequential and therefore more natural?
- Connection between FRAM and Envisioned World Problem?
- Next steps in this modeling work:
 - 'Running though' of **scenarios** illustrating ATCO and ERASMUS performance
 - More fine-tuning of the model and instances with observational data
 - Determination of ERASMUS consequences and risks with CPCs



FRAM Master's Thesis Projects

- Nuclear power plant fuel transportation "bottle" (Josephine Speziali, Karin Lundblad)
- En-route air traffic control (Daniel Sonnefjord)
- FRAM Visualizer (Peppe Bergqvist)
- Medical mishap analysis parallel to investigation board's RCA (Helen Alm)
- ...

