

FRAM 2009 Impressions

Notes taken during the 3rd FRAM workshop

Sophia Antipolis, France

16-19 February 2009

This note summarizes in an informal way ideas, frustrations and questions addressed during the 2009 FRAM workshop. A multidisciplinary group met to discuss various aspects of FRAM and its possible uses. The group originates from various professional backgrounds, such as road transport, railways, aviation, health care and oil & gas; each bringing different interests and views on FRAM. Probably owing to this variety, FRAM seems to be used well beyond accident analysis or risk assessment. Indeed, FRAM can be seen as a general framework, guiding research in very different ways. Namely, the so-called FRAMework has been used to monitor normal operations, as prose of accident investigation, as an alternative function analysis, as a model to identify indicators, and as a method to assess performance variability.

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Day 1 - Feb 16th

1.1 Variability with FRAM: Why, What, and How, Erik Hollnagel (MINES ParisTech)

Why (the purpose):

- System safety focuses on things that go wrong, people are used to identify causes and failures. RE look at things that go right and go wrong and look for variability, alone or combined can explain what happened. Does not rule out that one thing can trigger an event but most of the things happened because of a combination.
- We want things to go right. Things that go right (normal success) . We can only understand accidents by understanding normal operations.
- Threshold
- Recognisable is detectable. Looks at the outcome and look at supraliminal.
- FRAM looks at things subliminal that are below the threshold. We have a threshold, where is that threshold? It was not noticed at the time of the event or it was not realised in hindsight because we look for single events.
- It is insufficient to work out cause-effect relationships. You need to be able to understand how outcomes come about.

What

- Performance variability is not random but systematic. People do things in similar ways. There are important regularities. We need to understand internal and external conditions that causes an activity to be performed in a certain way; the influence of the workplace, the organisation.

Design to maintenance.

1984 focus was on the operation. Focus on what actually happens at work. The world was simply technological. There was no dependence. Concern was on what went wrong and the methods were developed for that.

Today, we have to consider the system the system not just at operation, we need to see how things come together. We also need to take management into account.

Tractable and intractable systems.

- We know what it is going on, tractable and understandable
- Intractable, we do not understand all the functions. The system changes in front of us every day. Underspecified we do not have complete? description of the system. We have new problems
- Performance variability is smaller for tractable systems. There is a scale. Intractable systems need performance variability.
- Performance variability is necessary because work situations are always underspecified, hence partly unpredictable

Six factors that influence variability:

- Inherent
- Social
- Contextual
- Ingenuity and creativity
- Organisational
- External

Dependency because people work in a social system

- ETTO and performance variability
- Shortage of time, resources, what can possibly happen

FRAM model can generate a set of possible instantiations to show the effect of the context (i.e. working conditions) on the system's performance. First, the FRAM model is generated. The model does not contain any connections. Then, the connections may be generated within an instantiation. The instantiation enables to identify actual and possible (potential) connections.

Model is the description of the functions

Instantiation are a specific set of conditions that something will happen. Coupling is not a cause-effect relationship. The coupling relates to dependencies.

Common Performance Conditions

How we use the FRAM to look at the future. Not particularly keen about the CPCs: it is just the starting point

Describe functions

Which type of function

Look at CPC adequate, inadequate or unpredictable

Which CPC affect which kind of functions

If there is a variability of a functions may have consequences, depending of how function is carried out may dampen or increase variability. If the output of a function is incorrect or incomplete, it may be affected by the conditions set by the CPCs.

How

It is not a causal propagation because functions are affected by aspects (input, control, preconditions, time, resources) or by the CPCs. .We should not simplify and set cause effect relationships. We cannot reduce to cause-effect relations

Relate CPCs to functions.

We have to pay attention to the possible symmetry between wanted and unwanted actions on the one hand, and probable and improbable.

FRAM looks at subliminal variability

The sphere of concern, when analysing systems, is broader than what it was 25 yrs ago.

Performance variability is necessary for underspecified situations.

1.2 Participants intro

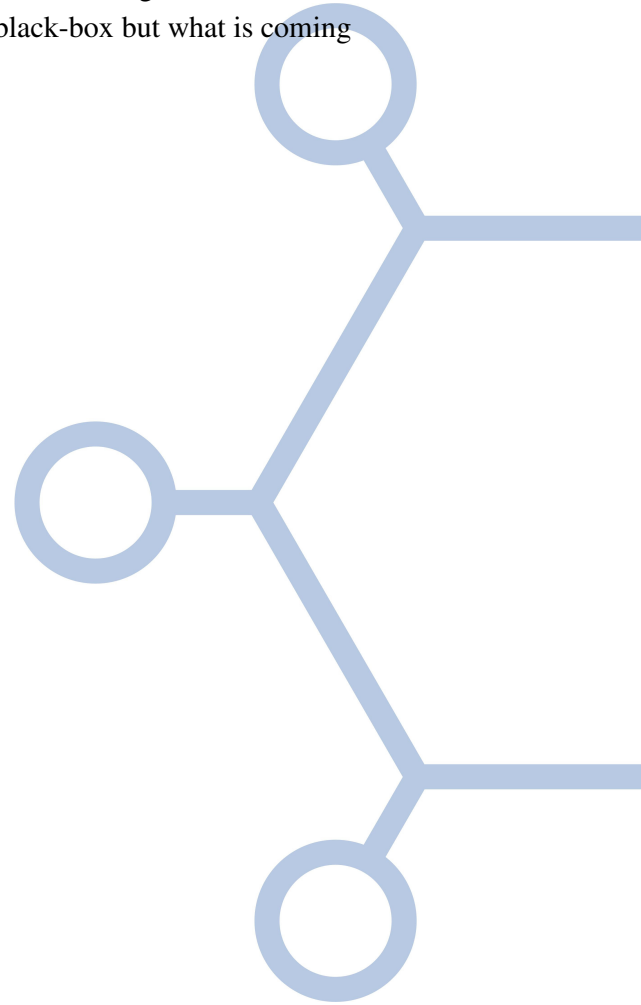
- Erik Hollnagel
- Eduardo Runte on understanding work as performed
- Pedro Ferreira on FRAM in railway systems
- Yu PhD HRA, Research university, Scandpower china, PSA nuclear power plant, interesting in HRA
- Fanny Rome Observations of normal activity in cockpit
- Philippe Cabon, Investigating relation between fatigue and safety
- Berit Tjorhom on safety within Norwegian Civil Aviation system parallel changes if they have impact on safety
- Didier Delaître on BEA investigation to a/c accident
- Magnus Nygreen Sweden on adapting CREAM to shipping consultant DS correcting action processes
- Mario Leone on audits, safety indicators, PhD in Madrid
- Rogier Woltjer on ATC automation applying FRAM to ATC incident analysis
- Elaine Pelletier analyst, background fine art
- Rob Robson on finding a way to understanding critical, non-linear relations. Better understanding needed to implement changes in the health care
- Camilla Tveiten on using FRAM model and analyse work processes
- Detlev Boltersdorf, Joerg Leonhardt applying FRAM in Air Traffic Management together with Luigi Macchi
- Denis Besnard, Damien Fabre, Ivonne Herrera, Eric Rigaud

1.3 Memories from 2008

- Several groups met in 2008: the skeptical group, the happy bunch, those who work, those who hope, the deep thinkers and the impatient ones (reference to a picture-based presentation of the 2008 edition of the workshop)
- What it is that FRAM do that the industry can use? What is it that we will produce?
- What is expected; which level of complexity are we ready to handle.
- Is the industry willing to change ?
- Visual simulation of what kind? A picture of the system? A visual representation?
- FRAM invites to look at the world in a different way and it is not a binary way. It is non-linear way. It is not a developed product but a conceptual framework. This framework helps to explore things in a different way. This shift will provide a better ability to understand

unpredictability, understand how functions can combine to lead to positive events. If we can solve problems, where is the next set of events likely to occur? FRAM is a combination of top-down and bottom-up approaches. It extracts relationships and patterns, world views from practical every day work. It shows what we may have. FRAM is in the leading edge. We are still at the point where we think in straight lines. We need to change the way in which we ask questions and investigate.

- People still think linear; we need to change our view of the world. A lot of terms can be used that expand the understanding.
- The world is not linear. In order to be practical, we turn it into something that is linear.
- Neural network. CEOs do not care about what is within the black-box but what is coming out from the black box.



Day 2 - Feb 17th

2.1 FRAM as prose of accident investigation: about a road near-collision, Didier Delaître (Bureau d'Enquêtes et d'Analyse)

FRAM in air accident investigation - Near Controlled Flight Into Terrain

Why plane move away from flight plan

From RE perspective why did the captain take that decision?

- 1-A function impact many operations during the flight
- 2-Information displayed was not the expected information

These aspects were found with FRAM and were not found by the original investigation. Also, some human factors issues were not identified before

Prosecution is not so common

Conclusions

Is FRAM relevant for simple cases?

Safety investigation is a need

Decisions as functions

The way data will be processed influences the way data is collected. Application of FRAM includes data collection since the beginning of the investigation. Start investigation with what occurred, the conditions for this specific situation. FRAM prose of accident investigation.

Distinction between judicial approach and safety approach. The legal system excludes the context. A safety investigation excludes the possibility of non linearity.

Helps investigate decision making.

- FRAM allows one to reanalyse cases that a traditional investigation might have overlooked.
- FRAM allows one to better capture people's behaviour.
- Rob said that lawyers expel the context from inquiries whereas safety investigations need it.
- DB : This situation might partly explain the differences found between judicial inquiries and context-sensitive accident investigation methods

2.2 FRAM in risk management in aviation – Tailstrikes. Fanny Rome (René Descartes Uni) - Use FRAM as a complementary tool for normal operations monitoring

- Reasons for selecting FRAM: it is a functional approach (regardless of airlines and SOPs) and it is based on variability rather than errors
- Start with incident reports to bring out common factors
- Different equipment that also justifies a functional approach
- Definition of the scope is based on Incidents and Accidents
- Use normal activity to describe the work situation

- FRAM shows the combination of failures. In the case presented it was possible to identify how two things that normally vary independently can represent a risk of failure when combined.

- Just look at functions related to speeds a lot of focus on V1 and V0. In a lot of cases, the speeds are erroneous. In all 10 cases where there is erroneous speed, rotation is too early. This happens because of a wrong calculation.

- The cockpit observations are about motions of humans and states of equipment. The analysis of the observations is to infer the actions occurring.

- Grid for observations

Analysis:

- Focus on three main functions and just three accidents

- Difficult to represent variability and what the reference is for variability, among pilots, airlines

- Many ways to manipulate the snow flakes

Main results:

- CPC rating is very binary

- Variability is socially constructed

- Preconditions are of different kind and relate to functions in a different way

- ROB-CPCs indicate how to populate useful information into function, accepting that there are parts that we are not going to understand

- Discussions with cabin crew and ground personnel

Open questions

Complementary to incidents analysis and observation

Usefulness of a FRAM analysis of normal activity for describing both observations and some troubles in the observation

Interesting to look at alternative ways that are not based on error.

2.3 Plenary discussion on accidents and risk management

Where is it that FRAM makes a difference? What is the added value in using FRAM?

A judicial inquiry obeys one state of mind, while accident investigation should have another state of mind

Get sufficient information to describe functions

What kind of functions do I have and do they describe all possible aspects?

Encompass as much information as possible

Tools always reduce complexity

There is a correlation between the a rarity of an accident and the depth of the investigation

For later discussion

Studying normal operation: how is this similar or dissimilar to an analysis of a failure?

Refine tools from observations of normal operations

Learn how to examine normal operations because we have more successful outcomes,

Try to describe the variability as much as you can

Who is doing the observations is crucial.

There is a need for a tool that can help improve a situation, FRAM can add one little piece to the puzzle. Ideally, one might want a full procedure.

Do I get a little piece of knowledge that gives me more than what I had before? YES

Do more investigations of normal operations

We need to know what we can do with FRAM and what we can not do

Is not possible to describe all type of events. There are unsuitable cases

A tool needs to provide some added value

There is an important complementarity between accident analysis and observation of normal work.

It is hard to see how CPCs alone could capture variability in functions ranging from technical to organisational.

Should there be more parameters?

Should FRAM functions be MTO (or anything else) -sensitive?

The judicial inquiry models miss information. This is where FRAM could find a way to sell itself

Analysing an accident is a dilemma between the necessary reduction of complexity imposed by a method and the overwhelming richness of the world.

Just who is carrying the investigation has an effect on the objectives pursued

2.4 FRAMing the rail engineering process planning - FRAM-based function analysis of a planning process (Pedro Ferreira, University of Nottingham)

Engineering planning process

If you are not able to plan adequately, you will not deliver what is required

Definition of functions. See if some functions are linked to high level functions
Defining performance conditions

Modelling FRAM using the Visualiser shows how functions are interdependent

A lot of sources of information, it is a mess

Primary input and primary output are more readable

Not functions like MTO

Questions

Recognising different characteristics may lead to better understand critical areas of the system as dampeners or sources of variability

Key areas are they origin of variability

I need to see my big picture and see where I need to focus

FRAM accumulates knowledge about the system and comes back to the big picture as a learning process. This helps learning about pattern of variability to reduce intractability

Comments

1.5 year planning, how this planning is going, what are the assumptions? What changes between the beginning of the planning and the end?

Pedro uses a mixture of finite nb of high-level functions (sufficient to describe typical planning management) but also acknowledges the richness (and further functions) contained within each of them.

2.5 The curious case(s) of Mr. “X”(s) or underspecification in Healthcare FRAM in healthcare (Rob Robson, Winnipeg Health Authority)

How do we integrate an analytic tool (intended to promote understanding of non-linear events and intractable elements in complex socio-technical systems) to the healthcare delivery process that is most comfortable in bi-modal functioning....

The curious case of Mr. Sinclair

Under-specification, intractability

One function, Register the patient

Time:

Resources...

The nature of healthcare includes many layers, multiple professional cultures, multi-centric visions. This guarantes a high level of under specification and intractability, impressive authority gradients, profound discomfort with conflict

Let’s try to be efficient and another will be thorough, somebody is through.

Hard to understand that 14 people have contact, and none of these people followed the ETTO principle

How many CPCs tolerate under specification?

How many parameters are mostly bi-modal?

How do functions in complex socio-technical systems link together when so many elements are intractable?

Most providers think they are “scientists” and still are comfortable in bi-modal thinking

Most patients have been made mute

What is normal is that normally nobody is certainly ill

What are the patient expectations and see if they match everyone’s expectations ; what about expectations of the conditions of their work?

Mr Sinclair was never registered after his arrival at the hospital. He died 34 hrs later. 14 people got contact with the patient but none looked after him properly.

A 1996 inquiry into Health system (or was it this precise hospital where the patient died?) took place. A number of cultural shortcomings were identified.

2.6 Plenary discussion on FRAM in critical service industries

Most of the CPCs are potentially unpredictable. How much information is predictable, how much is unpredictable? Things will happen, you have to keep a little reserve

What benefit for what depth of investigation. What do I want to reach? How much do I want to spend in the investigation? There is limited time

Increase the range of your radar

What is your position, being open to the possibility that you will never be able to identify? Is there a possibility of an unpredictable link? Openness allows to see different relationships different patterns.

Difference between unpredictable and unpredicted

There are regularities, even in hospitals even in airlines

ref. Turners information is available but is not processed

Health care - Things in real life are hard to predict and we have to live with this

Yes but FRAM increases the range of our radar, e.g. for safety assessment

Levels of abstraction/hierarchy/granularity are not mandatory for FRAM but might help in knowing where a function belongs?

Day 3 - Feb 18th

3.1 Modelling with FRAM in ATC (Joerg Leonhardt & Luigi Macchi)

Background

Try to introduce FRAM as safety assessments in Eurocontrol.

Start with tasks

What are we modelling and why are modelling

Assess human contribution to system safety, identify counter-measures; focus on the human activity, on the controller activity, from HRA into a more systemic approach

We need to decide what we need to model

Focus could be on the introduction of new functions

Try to define natural boundaries. These are not fixed all the time. It is necessary to have enough granularity to have enough information to capture variability

One needs to decide the granularity at which the analysis is carried

Function description

Achieve the description of normal activities.

Start from procedures and precedent task analysis using a verb that describes the function.

Interaction with ATC help to describe the activity of controlling an overflight

Normal work = prescribed but as discussed by operators

What operators actually do is variability as observed

A neutral description of how the system is supposed to work

The functions are the means to achieve a goal.

A function produces changes of state represented by outputs. There is a change in something. Change state is a result of a function. Use process to provide an overview and you have several functions.

In classical models, the links are present. In FRAM the propagation of events are not defined by predefined links

What is the relation between functions and tasks?

Functions can be carried out in different ways. This affects the variability of the function. A function that is carried by a computer has little flexibility while a function that is carried out by an organisation is more flexible.

Are we modelling functions or persons?

We should model functions but we tend to model the activity of a person. It is difficult to remember that it is not the person what we are modelling it is what she/he is doing and which aspects support her/his activity.

They describe what people do, that's is what we need to extract, what are the functions here. Functions help us to not focus on the sharp end. People describe their understanding. It is our work to translate this information into the model

Tasks and roles

Certain conditions lead the person to be more task-oriented than role-oriented. Role more global view and task is more precise. Would this affect functions

We are modelling the functions and not the roles

Tasks are functions performed in a structured way. Roles are functions as performed by persons

How do you deal with personal characteristics

If you use a HRA approach, you will assess how the controller will fail, while with FRAM you get very easily into the dependencies, in a different thinking getting away from the binary thinking

Joerg and Luigi use generic functions (a bit like Pedro) that can potentially be reused

3.2 FRAM Modelling (Details): FRAM as a modelling method for analysis of complex socio-technical systems - recursion, variability & function aspects (Rogier Woltjer, University of Linköping)

FRAM used as:

Air traffic control risk assessment

Analysis of team work in command and control

Aviation accident analysis

On aspects/parameters

Preconditions are states

Pre-conditions and resources are different type of aspects

Modelling variability within and across the functions

Two classes of parameters around the snowflakes

Criteria for aspects/parameters? What criteria should we use to determine what is a resource or a precondition. The important thing is how this parameters influence the variability of the function. Also, you need a definition of each parameter

Variability

The aspects/parameters are the result and the variability is related to the function.

Not everyone agrees. The output of a function is influenced in a different ways. The output is a state. Once the state is produced, it is necessary to question if the output is the right output. Then we can see preconditions (or other aspects) and interrogate the variability of the function, If the response comes too late every time the function is instantiated it produces an output. Function results is changed of state, phenotypes may be characterised. The function varies, instantiation is a snapshot of a function.

The output does not vary. A function can produce different outputs. The function may have a range of outputs.

Rogier combines CPCs and phenotypes (error modes)

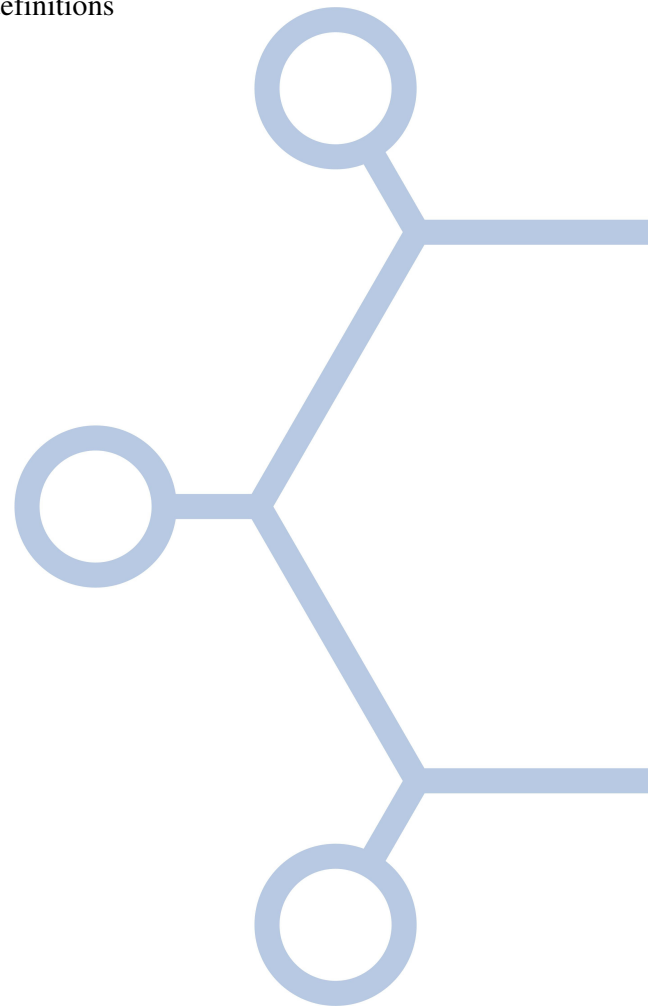
Rogier models Command & Control, ATC (and something else?) as similar systems for which one can zoom into a function to uncover more functions

3.3 What to look for when everything is normal? Monitoring safety performance & FRAM. Atelier on safety indicators in functions and at system level.

Very difficult exercise, not possible to separate indicators at a function or at a system level. There are no levels! If it is possible to identify the variability of the functions, it is possible to see how this variability interrelates with other functions.

People had different views on similar concepts

There is a need to create a glossary of useful terms, a list of definitions



Day 4 - Feb 19th

4.1 Wiki FRAM, FRAM FREAKY - FREAKY FRAM

What do we need to specify

6 parameters – aspects

Function

Process

State

System

Boundary

List of terms to be defined

1. Function
2. Granularity
3. Input
4. Output
5. Resource
6. Preconditions
7. Time
8. Control
9. System
10. Boundary
11. State
12. Variability
13. Resonance
14. Task
15. Role
16. Subliminal
17. Supraliminal
18. Indicators
19. Barriers
20. Damping
21. Safety
22. Normal Operation
23. CPCs
24. PSF
25. Entity
26. Success
27. Outcome
28. Process



29. Performance

30. Activity and task is more related with what humans do, we need

31. Name for the bubbles: Bobbles notes, aspects, slots, other called them parameters, parameters are too strong, descriptor, descriptor (rigid): aspect (vague).

What we (Erik?) really need(s) to define...

1. The bubbles are: Input, Output, Preconditions, Resources, Time, Control
2. Performance variability, we are interested in the variability of performance
3. System
4. Function
5. Safety pattern or connections and emerge out of those connections in an unpredictable way
6. Say what is safety in the concept of FRAM
7. Success-Safety-Failures
8. Normal Operation
9. System (Boundary)
10. Resonance
11. Degree of detail
12. State – change of state (or outcome) change of state is an outcome

4.2 Plenary discussion on future developments

What suggestions would be most useful to expand the understanding of a method?

Tutorial for a collective analysis

Invite people from industry and have a professional demonstration of FRAM

List of documents, bibliography

Prepare a case and have an interview

Comparing FRAM & STAMP

FRAM course

Development of operation assessment

Develop samples

Have small groups to discuss the same case and then compare the result of discussion

Dynamic tool perspective for dynamic situations

Have some added value to bring back home

W to be followed: lab and development group, Instrumental / summer school, PhD thesis

Difficulties and facilities in applying FRAM

Focus on data source and data collection

Share templates of the tools used to accident analysis via the e-room

Control

- Two types of variability in the situation (acute conditions) and across the situation (common situations, they do not expect to vary during). These performance conditions that affect in short time

- Two mode of propagation by the couplings and another that is indirect
- Arguments for using FRAM
- System-/organisation-oriented
 - Not bi-modal or linear
 - Focus on function and not individual (sharp-end)
 - Use FRAM to ask questions to the accident investigator that (s)he did not think about
 - The art of thinking together, ability to hold conflicting ideas in the same space



End of notes