FRAM – First Steps

How to Use FRAM and the FMV

Erik Hollnagel

Professor, University of Southern Denmark
Chief Consultant Center for Quality, RSD (DK)

hollnagel.erik@gmail.com

FRAM analysis steps

Safe tysyn thesis

0 Describe the purpose of modelling and identify the activity being analysed. An event that has occurred, an ongoing activity, a planned future scenario.

1 Identify and describe the essential functions in the activity using the FMV; characterise each function by means of the relevant aspects. The FMV will indicate when the model is finished (consistent).

2 Characterise the typical / potential variability of 'foreground' functions using the FMV. Consider both everyday and excessive cases of variability.

3 Analyse one or more instantiations of the model and look for possible functional resonance based on potential / actual dependencies (couplings) among functions.

4 Propose ways to monitor and manage performance variability (indicators, barriers, design / modification, etc.)

Identifying Functions: General

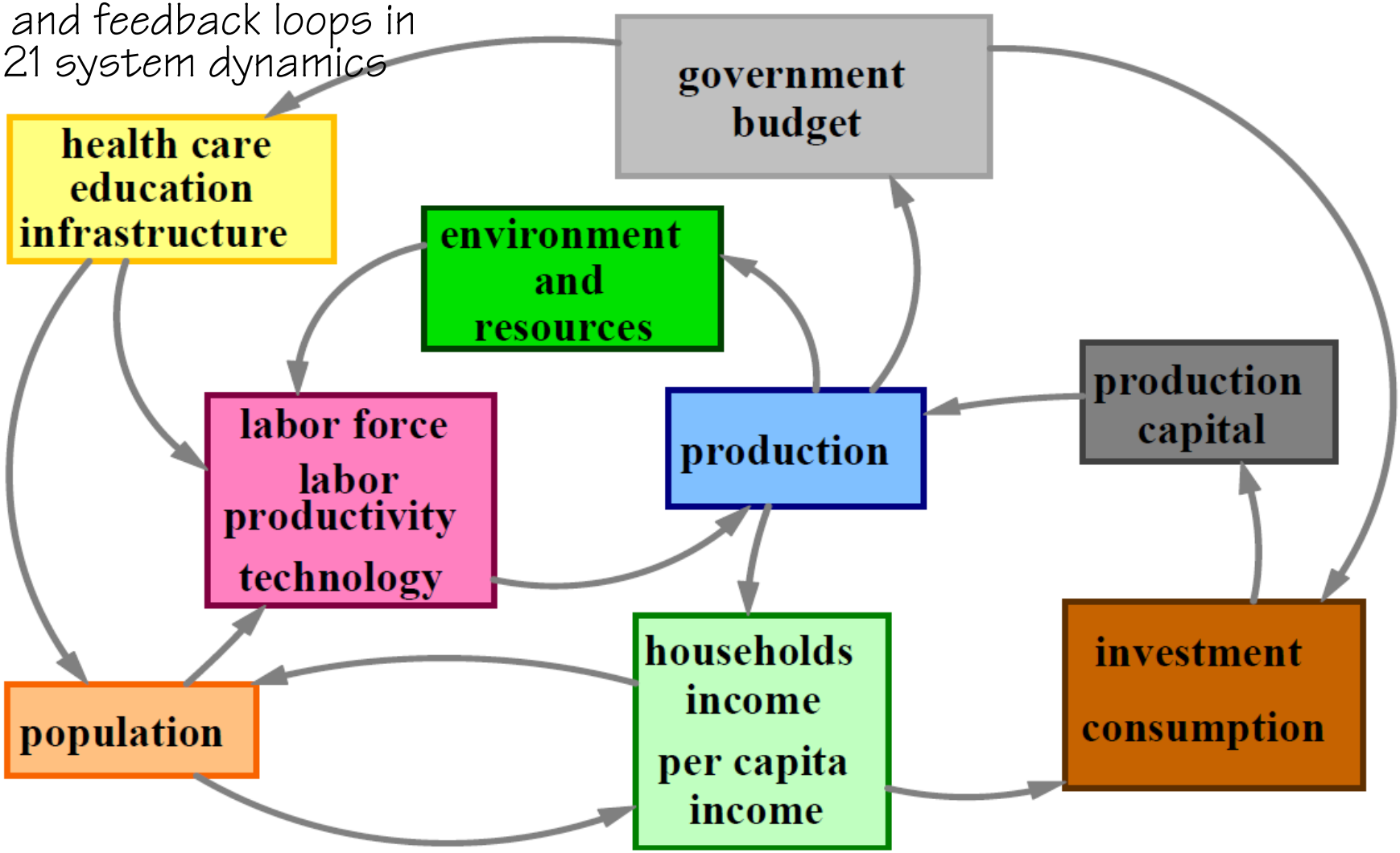
PURPOSE: To explain how a system functions (or should function) when it performs as it should (i.e., everyday or typical performance), and to understand the variability which alone or in combination may prevent that from happening.

MODEL: A FRAM model describes a system's functions and the potential couplings among functions. The model does not describe or depict an actual sequence of events, such as an accident or a future scenario.

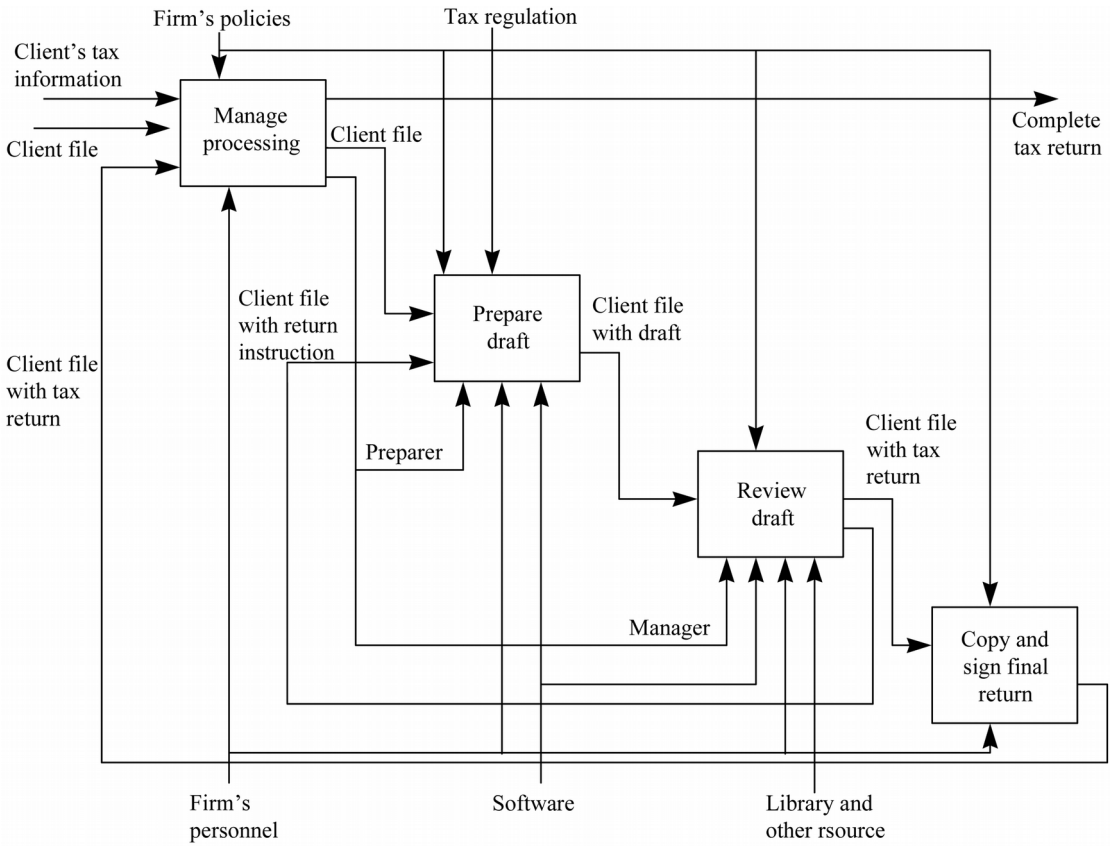
INSTANTIATION: A concrete scenario is the result of an instantiation of the model. The instantiation is a "map" of how functions are coupled, or may become coupled, under given – favourable or unfavourable - conditions.

Models: Boxes and arrows

Structure and feedback loops in Threshold 21 system dynamics model

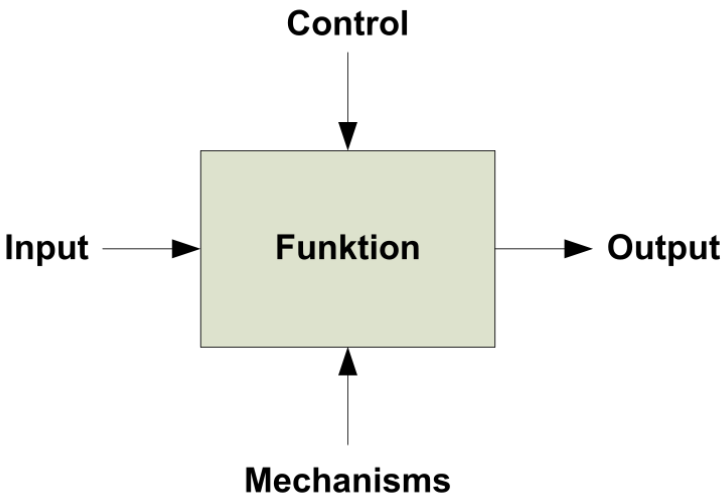


The meaning of connectors



Source: Congram and Epelman (1995)

Structured analysis and design technique

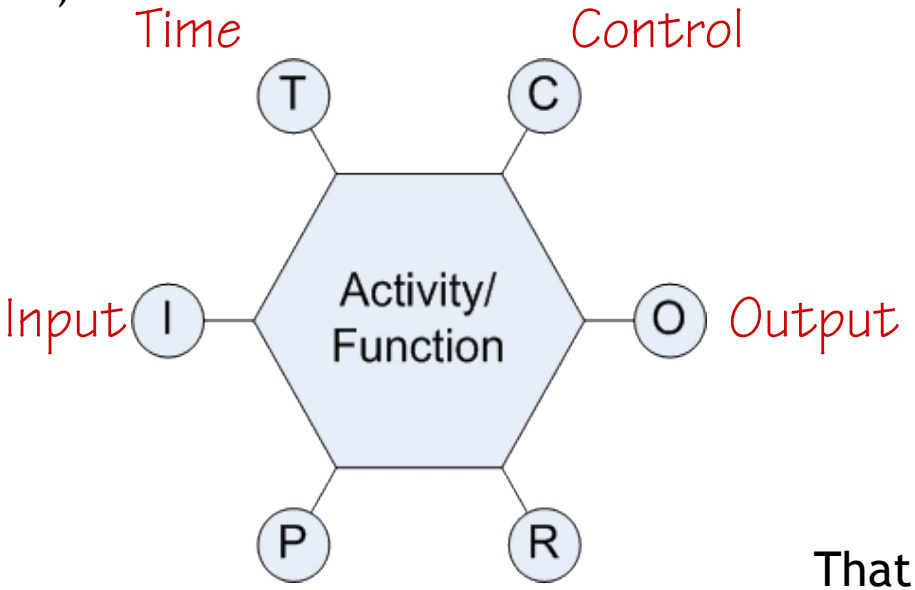


The connectors represent defined relations

Describing a FRAM function

Temporal aspects that affect how the function is carried out (constraint, resource).

That which supervises or regulates the function. E.g., plans, procedures, guidelines or other functions.



That which activates the function and/or is used or transformed to produce the output. Constitutes the link to upstream functions.

That which is the result of the function. Constitutes the links to downstream functions.

System conditions that must be fulfilled before a function can be carried out.

That which is needed or consumed by the function when it is active (matter, energy, competence, software, manpower).

Getting cash from an ATM

Describe what you *do* to get money from an ATM.
Write it as you would explain it to someone else.

Describe what you *do* – and what the ATM-as-a-system *does* – <u>when everything works as it should</u>. In other words, describe the typical case. Do not yet include possible ways in which it could go wrong. That will come later.

Go through the description and mark all functions. Rewrite them in the infinitive form ("to xxx").

7 easy steps to get cash from an ATM

Safe tysyn thesis

Step 1. Insert your card into the ATM machine (with the side that has the arrow going in first.)

Step 2. Enter your pin when prompted by the machine then press proceed button.

Step 3. Select the "withdrawal" option by pressing the button next to it when prompted by the machine.

Step 4. Select your type of account "Current or Savings" option by pressing the button next to it when prompted by the machine.

Step 5. Select the amount you want by pressing the button next to it when prompted by the machine.

Step 6. The machine will request if you want a receipt for the transaction?

Proceed with the desired by pressing either the Yes or No button.

Step 7. Once the transaction is completed, the machine will;

Dispense the amount to you.

Dispense the receipt on the amount (If you had selected the Yes button in Step 6).

Release your ATM Card.

See also: m.wikihow.com/Use-an-ATM

Describing the functions

Begin to describe the functions using the FMV. Build the model using a breadth-before-depth principle.

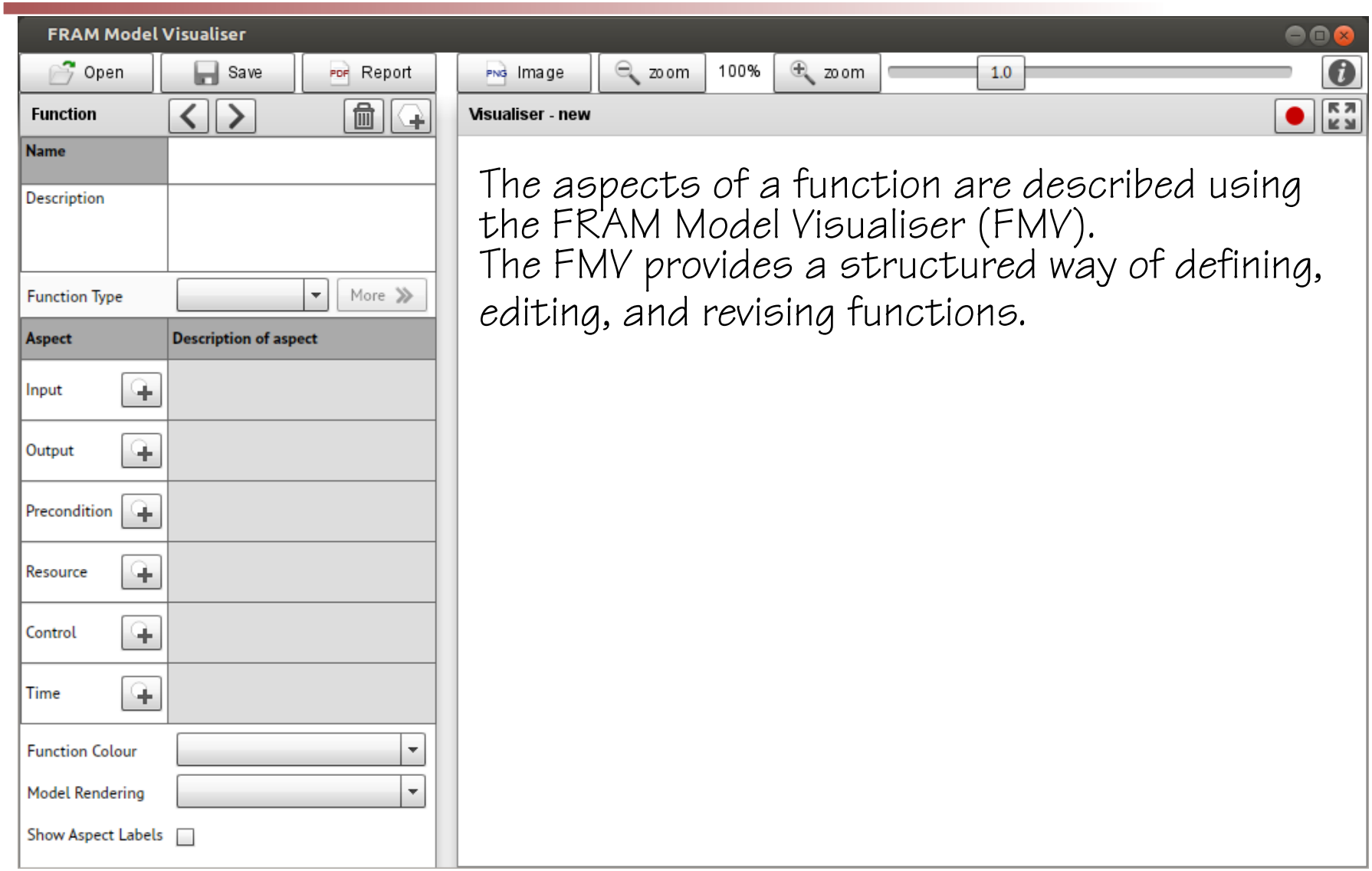
Depth-before-breadth

The usual way to carry out an analysis is depth-before-breadth.
In accident investigations this is illustrated by the search for the root cause.
In decision making this is illustrated by exploring the consequences of each alternative before other paths are considered.

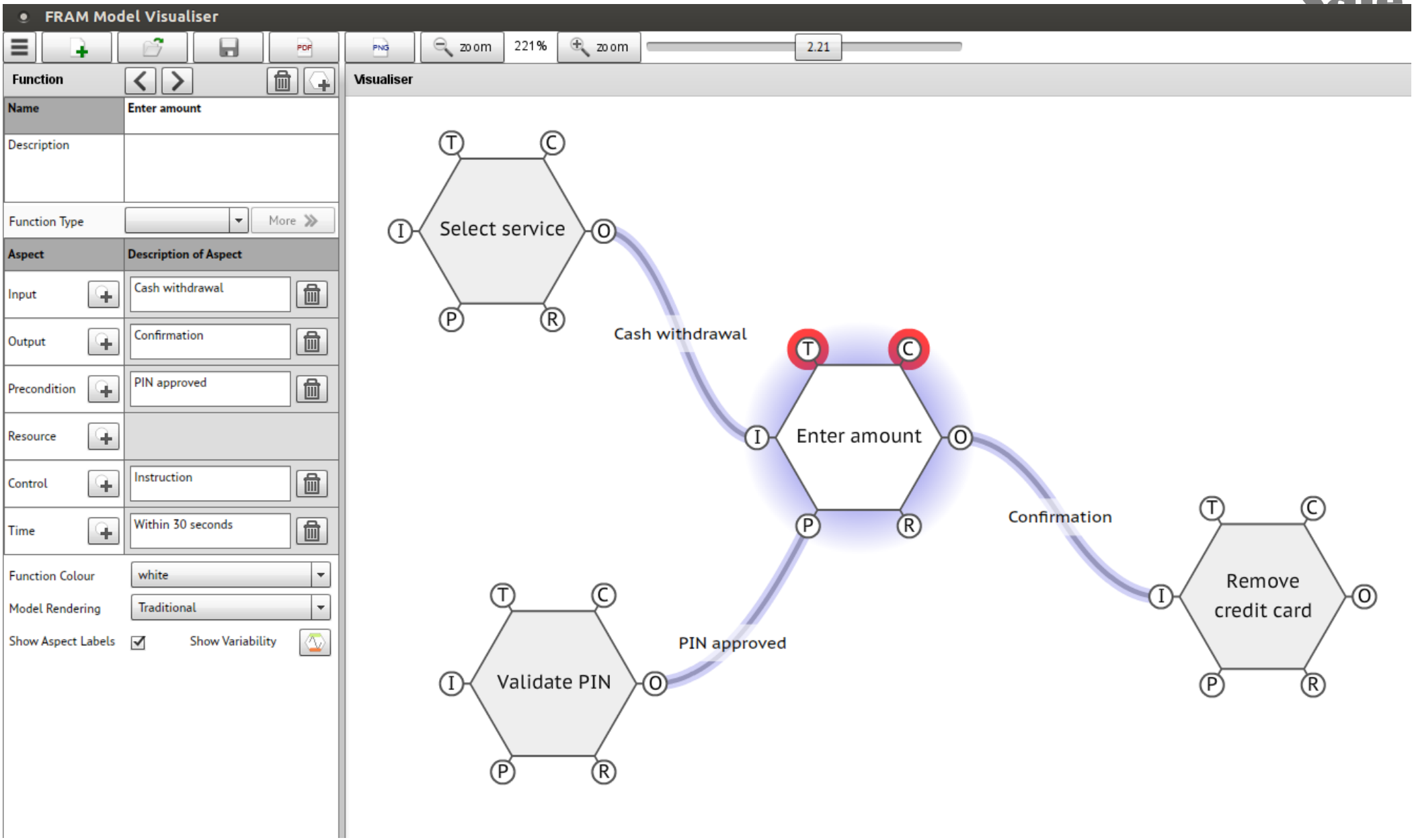
Breadth-before-depth

When building a FRAM model, try to describe the activity as a whole, before going into detail with specific functions.
Try to understand the "big picture" – the activity in its context – before getting lost in details.

Describing the aspects



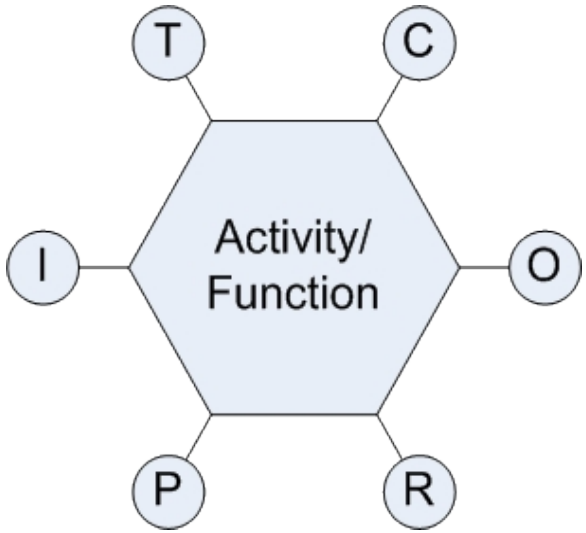
The aspects of a function are described using the FRAM Model Visualiser (FMV).
The FMV provides a structured way of defining, editing, and revising functions.



FRAM: Characterisation of input

That which is taken in, or operated on by a function, and used as basis for the Output. The Input can be matter, energy, or information. The 'signal' that activates or starts a function (command, information, clearance, instruction). A change of state of the environment, e.g., a piece of paper in an in-tray, an order to a chef, a new patient in an emergency room, no more cars waiting on the quay, etc.

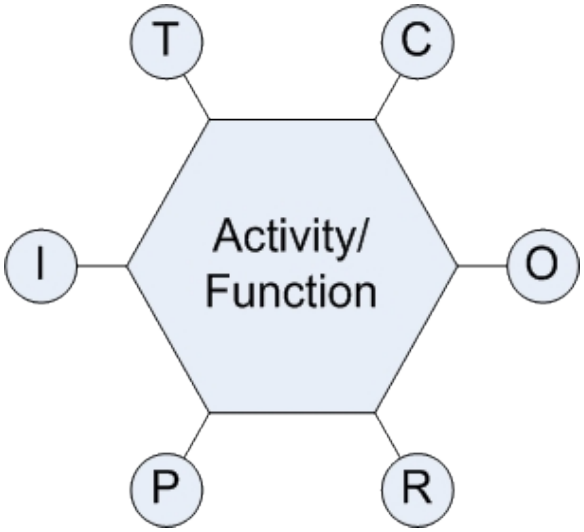
Input



All Inputs must have an origin or source, which means that an input to one function must be the Output from another function.

Designated foreground functions must have defined Inputs, while designated background functions need not have.
If a foreground function does not have en Input, it will never be carried out!

FRAM: Characterisation of output



Output

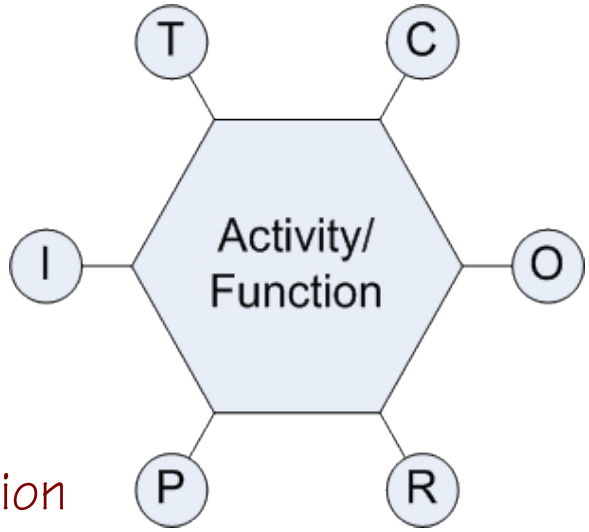
The result of the function, or what is produced or manufactured by the function. The Output can represent matter, energy, or information, for instance, a decision, a command issued, or the result of some kind of deliberation.
The output represents a change of state – of the system or of one or more output parameters.

The Output makes clear how variability can propagate through a system. If a function varies then it is also likely to vary in some way. Since the Output from an upstream function will be the Input to a downstream function, variability of the Output may lead to variability in the (downstream) function, and so on.

All functions, except a designated drain (or sink) must have an Output.

FRAM: Characterisation of precondition

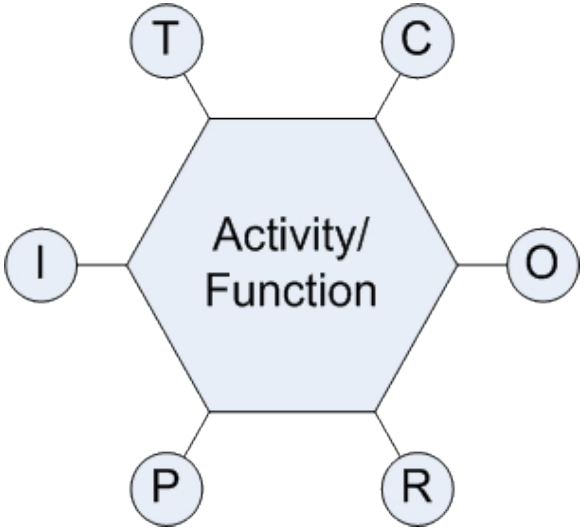
The system conditions that must be satisfied before a function is carried out. The Preconditions must be the Output from one or more other functions. Preconditions provide demonstrate how functions can be coupled.



Precondition

A Precondition is a state that must be true before a function is carried out, but it is not itself the signal that starts the function. An Input, on the other hand, can start the activation of a function.

FRAM: Characterisation of resource



Resources
(execution conditions)

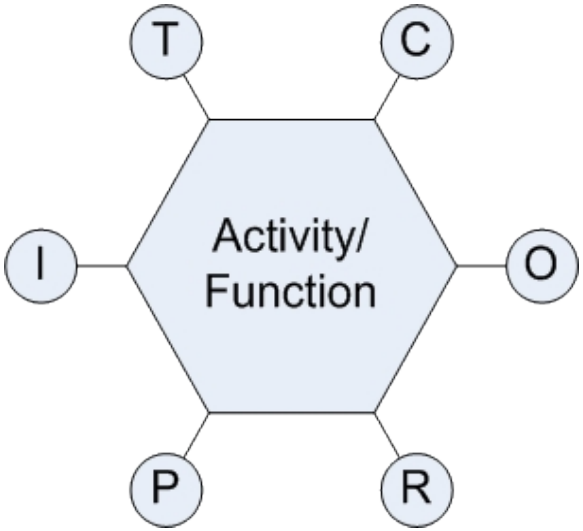
Something that is needed when a function is carried out - matter, energy, information, competence, software, tools, manpower, etc. A Resource is consumed while the function is carried out. Execution conditions must be present for the function to be carried out, but are not diminished because of that, e.g., data, competence, or skills.

Resources must be produced by one or more functions. Execution conditions are assumed to be stable for the duration of the event (output from 'dummy' functions).

FRAM: Characterisation of control

Safe tysyn thesis

Control



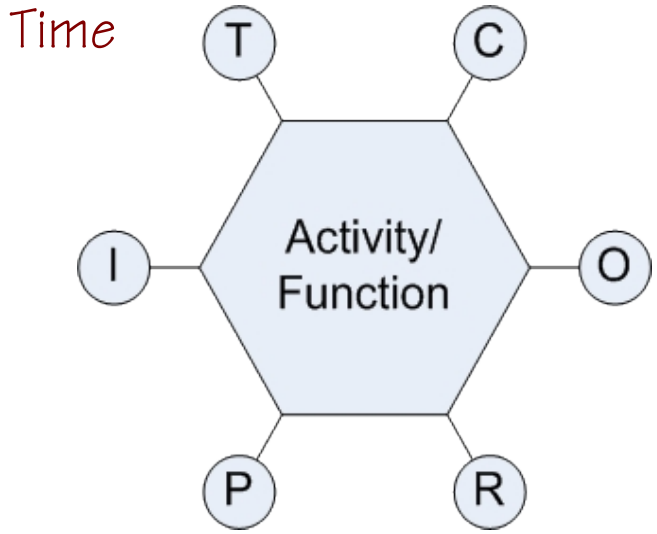
Something that supervises or regulates the function to ensure that it produces the desired output - plans, schedules, procedures, guidelines or instructions, etc. Control can also be the conditions that constrain the sequencing of sub-steps. Explicit control is provided by another function (procedures, instructions). Social control is the expectations of others (company, management, colleagues) or of the agent itself.

Control must be the Output from an upstream function. If it is stable, then it is reasonable to assign it to a background function. If it is active and adaptive, then it should be assigned to a foreground function.

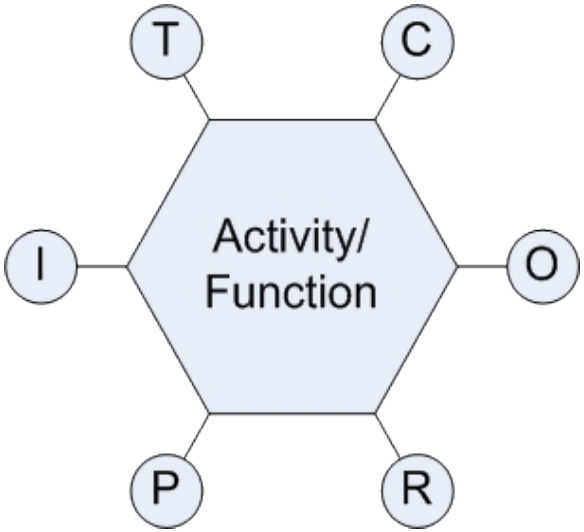
FRAM: Characterisation of time

This aspect represents the various ways in which time can affect performance.
Time as control: relative or absolute sequencing conditions.
- Earliest Starting Time (EST),
- Latest Starting Time (LST),
- Earliest Finishing Time (EFT), and
- Latest Finishing Time (LFT).

Time as a resource: time available, deadline, etc.
Time as a precondition: clock-time or relative to other functions.



More about the aspects



It is not necessary to define all six aspects for every function.
In practice, you should only describe the aspect that seem to be relevant or necessary, based on knowledge about the activity.
For each type of aspect there can be more than one entry.
A function may, for instance have a single Output that used by several downstream functions.
A function may also have two – or more Outputs.

A function may also have two – or more – upstream couplings to its Input, Precondition, Resource, Control, or Time aspects.

Data collection

Safe tysyn thesis

"Work-as-imagined"

The various sources, descriptions or specifications, for the type of work being studied.

- Policies, strategies, guidelines, instructions, checklists
- Documented experiences (cases, events, statistics)
- Workplace layout and organisation, equipment, facilities.

"Work-as-done"

The various ways in which information about actual work practices can be obtained.

- Interviews – open and appreciative questions
- Checklists to guide interviewers
- Information about attitudes, habits, assumptions, tacit knowledge
- Typical adjustments (variability)
- Dependencies among functions, conditions that affect performance

Interviews

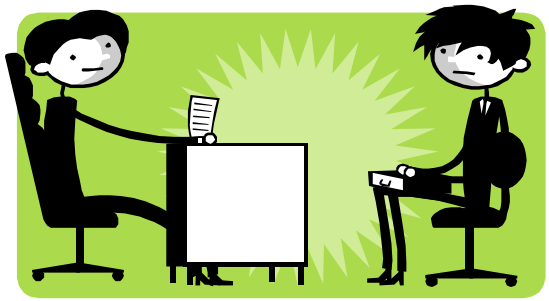
Interviews should be conducted at the place of work (on-site), although not necessarily where the specific work or activity is carried out.

Interviews should be conducted in small groups, e.g., two from the staff and two from the analysis group.

> Having more than one interviewee can help to get more information about daily practices and to show both shared assumptions and individual work patterns.
>
> Having more than one interviewer means that one can focus on asking questions and listen for answers, while the other can focus on taking notes.

Check-lists should be used to keep interviews on track and to ensure no questions have been missed.

Duration is typically 1-2 hours.



Asking the right questions

The purpose of the data collection is to find out what team members do every day to get the task done successfully, how this may vary, and how this understanding may improve how they do their work (in terms of safety, productivity, etc.)

As such the researcher/observer should observe the team undertaking tasks and ask questions according to the spirit of the FRAM.

Notes will be made from observations and discussions with team members
The observations/questions may be conducted over a number of weeks asking slightly different questions each week.

The goal is not to question whether work is being done correctly (work-as-imagined) but to understand what was being done and why (work-as-done).

Use pre-defined questionnaires carefully. During an interview it is more important to listen to what people say, than prepare the next question (from a list).

Sample questions

How well is the activity described? (simple, detailed)
What are the key functions?
Are preconditions always identified and/or fulfilled?
Is guidance provided on the variability associated with key functions?
Are controls identified and described?
Are resources available when they are required?

What's the best way to do it?
Is that like training?
Do you or your colleagues ever change it around?
Does anything unexpected ever happen? Tell me about it.
Is there anything that could be better, anything you feel you have to put up with?
Do you need any special tools to in your work?
So how do you know the quality is okay?
If you need a team leader or manager, do you stop and call them or do you keep working until you see them?
What do you do if the task is running behind?

Identifying Functions: Details

Where to begin	A FRAM analysis can in principle begin with any function. The analysis will show the need for other functions to be included, i.e., functions that are coupled or linked through various relations (aspects). FRAM defines six types of relations / aspets.
Level of description	There is no single, correct level of description. A FRAM model will typically comprise functions described on different levels.
Foreground background	Functions are pragmatically labelled as being either foreground or background functions.
Level of detail	If there can be significant variability in a foreground function, then it is possible to go deeper into the analysis of that function, and possibly break it down into subfunctions.
System boundary (stop rule)	The analysis may go beyond the boundaries of the system as initially defined. If some background function can vary and thereby affect foreground functions "inside" the system, then it should be considered a foreground function.

Foreground and background (functions)

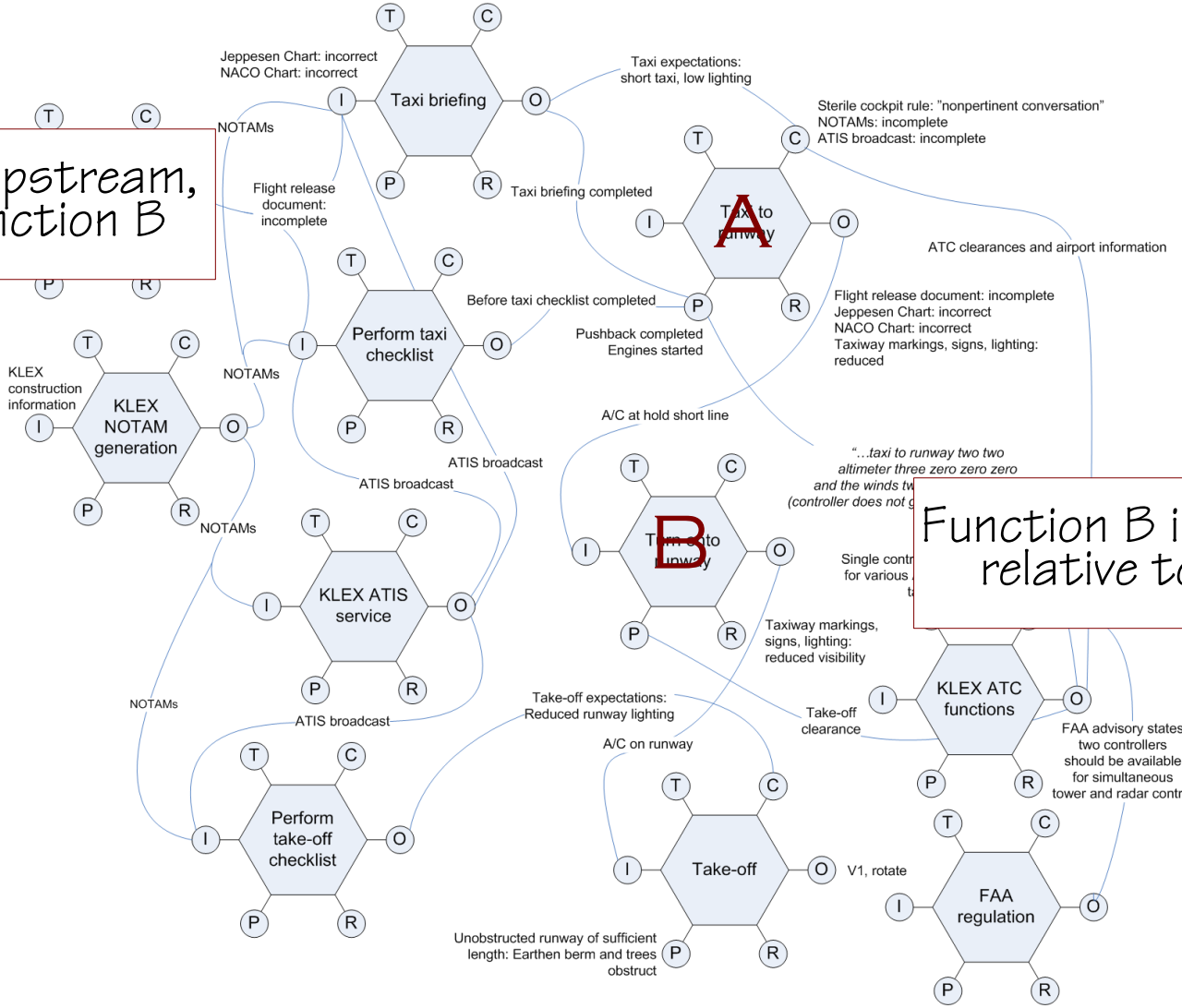
FRAM uses a distinction between foreground and background functions, which may all affect performance variability.
Foreground functions are directly associated with the activity being modelled and may vary significantly during a scenario.
Background functions refer to common conditions that may vary more slowly.

The distinction between foreground and background functions is relative rather than absolute.
A 'background' function may be analysed further, and thereby becomes a 'foreground' function.

Both sets of functions should be calibrated as far as possible using information extracted from accident databases.

Upstream and downstream

Function A is upstream, relative to function B



Function B is downstream, relative to function A