



# myFRAM

## User Guide

myFRAM 1.0.1 – June 2018

*myFRAM is a custom add-in for Microsoft Excel designed to support FRAM (Functional Resonance Analysis Method) analysis and released freely by the "Industrial Systems Engineering" research group of Sapienza University of Rome (Italy) – Department of Mechanical and Aerospace Engineering. myFRAM mainly relies on professor Hollnagel's book [1], and on other scientific manuscripts cited throughout this user guide.*

If you use myFRAM for your FRAM analysis, please give credit to our work citing our conference paper about myFRAM design and concept idea:

Patriarca, R., Di Gravio, G., Costantino, F., "myFRAM: An open tool support for the functional resonance analysis method," *2017 2nd International Conference on System Reliability and Safety (ICSRS)*, Milan, 2017, pp. 439-443. doi: 10.1109/ICSRS.2017.8272861

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**DISCLAIMER:** MS Excel is required to run myFRAM. myFRAM generates also file readable by the FRAM Model Visualizer (FMV) [2], which is an open tool for visualization of FRAM models and can be downloaded for free at the functional resonance [website](#). myFRAM cannot be used in its original (or repacked form) before previous consent by the Licensor (see EULA, in §4).

## 1. Introduction

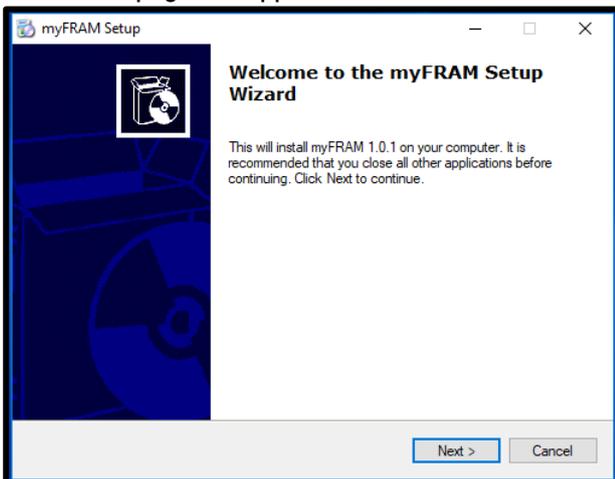
myFRAM is an open tool, released by the “Industrial Systems Engineering” group of Sapienza University of Rome (Italy). The research group designed, developed and released it freely in order to support the applicability of the Functional Resonance Analysis Method (FRAM) and stimulate new perspectives for the analysis of complex socio-technical systems. Further information are available on the group’s [website](#), which details their past and ongoing research activities on resilience, and resilience engineering.

Section 2 details the installation steps to use myFRAM. Section 3 presents the functionalities, detailing each specific button. Section 4 presents the license agreement.

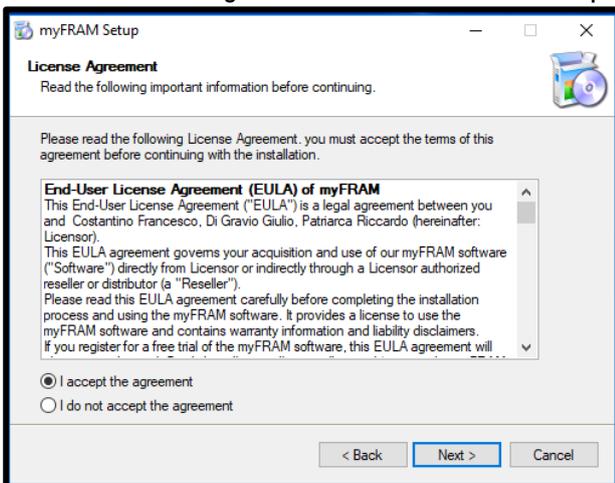
## 2. Installing/Uninstalling

### 2.1. Installing steps

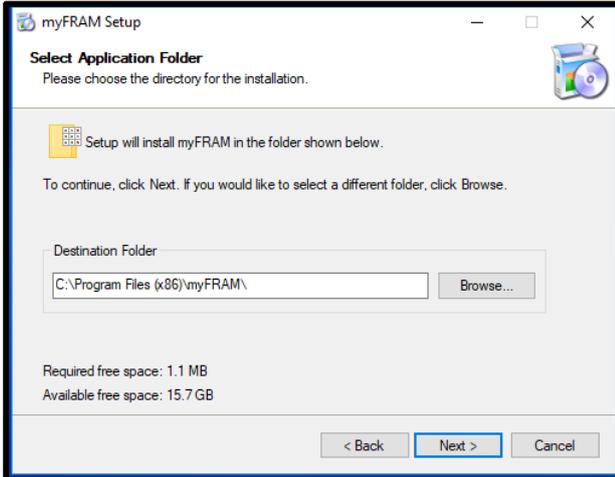
Once opened the archive, double click on myFRAM\_setup to launch the installation process. A welcome page will appear, click on <Next> to continue with the process.



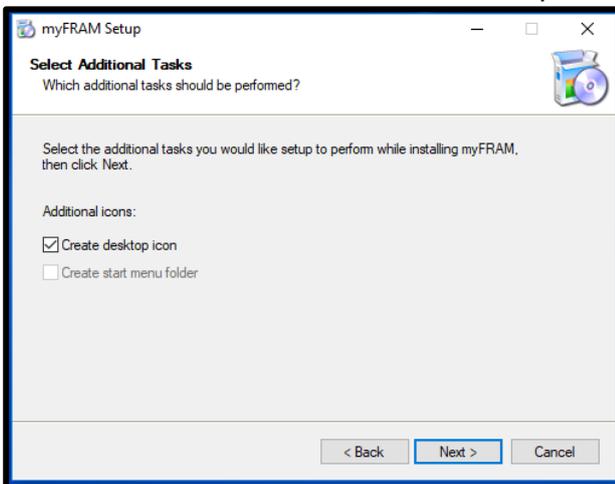
Read the License Agreement. You will have to accept it to proceed with the setup steps.



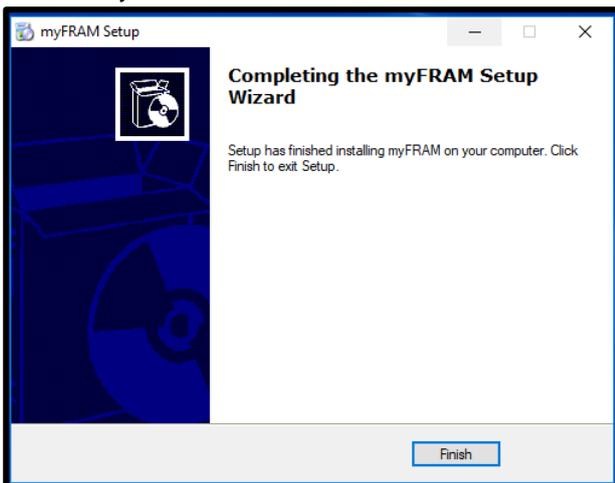
Select the installation folder. Note that the required space for myFRAM is approximately 1Mb.



Decide the additional tasks for the installation process (Desktop icon, Start menu folder) - *recommended*.



And, finally, click on <Finish> to conclude the installation process.

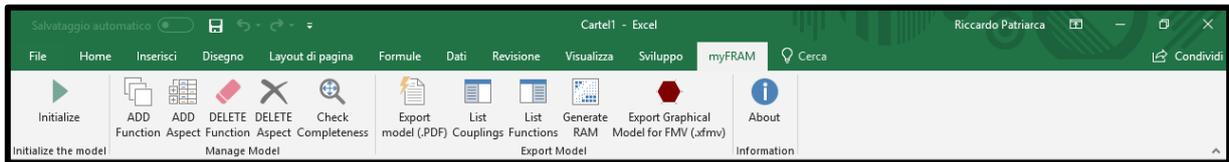


## 2.2. Uninstalling steps

myFRAM can be easily uninstalled using the Uninstall.exe provided in the setup directory. Alternatively, it can be uninstalled through the standard uninstallation procedure from Windows Control Panel.

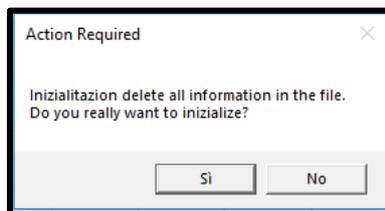
### 3. Using myFRAM

To start using myFRAM you can easily double-click on your desktop icon, or open the file path where you downloaded it. This action will automatically open the MS Excel version available in your computer. Once opened MS Excel, you will be asked to activate the macros, necessary to proceed with the usage of myFRAM. Note that this is a mandatory step, since myFRAM is based on VBA language (Visual Basic for Application): there is no malicious intention behind it. Once activated the macros, you will get an extra toolbar on your MS Excel standard one, which includes all the currently available functionalities of myFRAM.



#### 3.1. Initialize

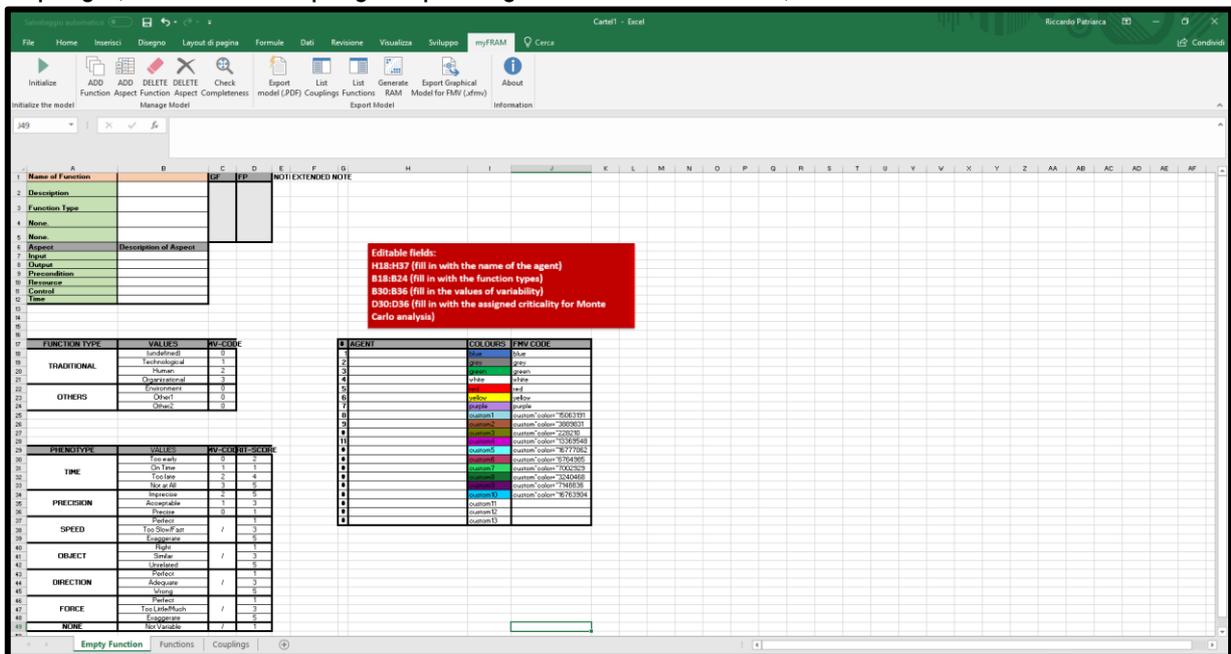
To start the model, you will need to initialize it. "Initialize" will create the source sheet for the subsequent analysis. After clicking on "Initialize", the user will receive a confirmation message:



**Note that the confirmation will wipe out the data already included in the worksheet. Confirm very carefully!!!**

The initialization command will create three sheets:

- Empty function (general model data)
- Functions (list of FRAM functions, an empty sheet soon after initialization)
- Couplings (list of FRAM couplings, depending on the FRAM functions)



### 3.1.1. Sheet: Empty Function

The sheet “Empty Function” includes the basic information used to structure the subsequent FRAM analysis. Main data refer to the general tabular formulation for a FRAM function. In particular, the table representation is the framework used to generate functions and cannot be modified directly by the user (in the range A1: F12) in order to ensure the consistency of the analysis. Nevertheless, the user will be allowed to fill-in the basic structure, with free text or with listed values depending on specific fields, as explicitly detailed below.

	A	B	C	D	E	F
1	Name of Function		GF	FP	NOTE	EXTENDED NOTE
2	Description					
3	Function Type					
4	None.					
5	None.					
6	Aspect	Description of Aspect				
7	Input					
8	Output					
9	Precondition					
10	Resource					
11	Control					
12	Time					

#### About the fields:

- ❖ Name of Function: name of the function, can be filled in with free text.
- ❖ Function Type: a categorization of the function, and can be filled in with values depending on the cells B18:B24 (which are editable by the user). Currently, in compliance with the current version of FMV, the only values readable in FMV are the ones referred to Traditional FRAM functions (B18:B21), so that the other assigned values will remain into the MS Excel file, but they will not be translated into FMV language.

FUNCTION TYPE	VALUES	FMV-CODE
TRADITIONAL	(undefined)	0
	Technological	1
	Human	2
	Organisational	3
OTHERS	Environment	0
	Other1	0
	Other2	0

- ❖ Description: an extended description for the function, to clarify the identifier. It can be filled in with free text.
- ❖ The field None, None: fields used to define different phenotypes of variability. They assume the values “None” “None” since they have not been initialized at this step of the model (they will be customized during the analysis). They follow FRAM traditional phenotypes, letting the user editing/choosing them to create additional phenotypes, if necessary. These fields can be filled in with values depending on the cells B30:B49. Currently, in compliance with the current version of FMV, the only values readable in FMV are the ones referred to Timing and Precision (B30:B36), thus the other assigned values will be stored into the MS Excel file, but they will not be translated into FMV language.

PHENOTYPE	VALUES	FMV-COD	CRIT-SCORE
TIMING	Too early	0	2
	On Time	1	1
	Too late	2	4
	Not at All	3	5
PRECISION	Imprecise	2	5
	Acceptable	1	3
	Precise	0	1
SPEED	Perfect	/	1
	Too Slow/Fast		3
	Exaggerate		5
OBJECT	Right	/	1
	Similar		3
	Unrelated		5
DIRECTION	Perfect	/	1
	Adequate		3
	Wrong		5
FORCE	Perfect	/	1
	Too Little/Much		3
	Exaggerate		5
NONE	Not Variable	/	1

- ❖ Input, Output, Precondition, Resource, Control, Time: the six FRAM aspects, can be filled in with free text. Note that the connection will be allowed only between an upstream Output and any downstream input (Input, Precondition, Resource, Control, Time). The connection will be allowed only if two (or more) aspects have the same syntax.
- ❖ The field GF (namely “Generalized Function”) and the field FP (namely “Functional Purpose”) are used to support the analysis based on a multi-layer representation. In particular, they refer to a mapping strategy based on grouping functions that refer to the same macro-function (multiple functions constitute a GF), and respectively to the a more abstract macro-function (multiple GFs constitute an FP). This theoretical representation refers to the Abstraction/Agency framework, conceptually discussed in [3].

A simpler interpretation of this multi-layer framework can be linked to the usage of the field FP as a means to identify the colour of the function, and link it (e.g.) to different agents, as suggested in the G17:I37 table; or different processes. In particular, it is possible to fill in the Agent name (second column of the table, H18:H37), corresponding to the selected colour (third column, I18:I37), which will be associated to an FMV code (fourth column, J18:J37).

#	AGENT	COLOURS	FMV CODE
1		blue	blue
2		grey	grey
3		green	green
4		white	white
5		red	red
6		yellow	yellow
7		purple	purple
8		custom1	custom"color="15063191
9		custom2	custom"color="3889831
10		custom3	custom"color="228210
11		custom4	custom"color="13369548
12		custom5	custom"color="16777062
13		custom6	custom"color="6764985
14		custom7	custom"color="7002929
15		custom8	custom"color="3240468
16		custom9	custom"color="7148836
17		custom10	custom"color="16763904
18		custom11	
19		custom12	
20		custom13	

- ❖ The Note and Extended Note are free text fields thought to collect additional information for each aspect included in the analysis.

### 3.1.2. Sheet: Functions

The sheet “Functions” is the core of the model and of the subsequent analyses. It will contain the list of FRAM functions used for the analysis. It will further show an indicator counting the number of FRAM functions included in the model (cell: G3). This sheet will be filled in by means of the following commands: Add Function (§3.2), Delete Function (§3.3), Add Aspect (§3.4), Delete Aspect (§3.5), Check Completeness (§3.6).

### 3.1.3. Sheet: Couplings

The sheet “Couplings” represents a systematic summary of the upstream/downstream connections associated with all the details included in the function building process. This sheet will be filled in by means of the command List Couplings (§3.8).

### 3.2. Add Function

This functionality adds a new empty function in the sheet “Functions”, at the end of the model. Each field can be filled in with free text (for the fields: Name of Function, Description, Input, Output, Precondition, Resource, Control, Time), or selecting an alternative from the dropdown menu (for the fields: Function Type, Phenotypes of variability, i.e. None and None, GF, FP), based on the information defined in the sheet “Empty Function”.

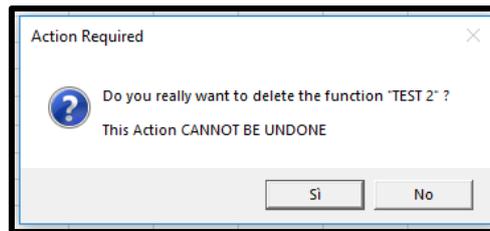
	A	B	C	D
1				
2	Name of Function	TEST 1	GF	FP
3	Description			blue
4	Function Type			
5	None.			
6	None.			
7	Aspect	Description of Aspect		
8	Input	INPUT test 1		
9	Output	OUTPUT test 1		
10	Precondition			
11	Resource	RESOURCE test 1		
12	Control			
13	Time			

As an example, look at a finalized function, showing the combined free text/dropdown menu text management.

	A	B	C	D
1				
2	Name of Function	TEST 1	GF	FP
3	Description	This is the description of function TEST1		blue
4	Function Type			
5	TimeVar.	Too early		
6	PrecisionVar.			
	TimeVar.			
	PrecisionVar.			
	SpeedVar.	1		
	ObjectVar.	st 1		
	DirectionVar.			
	ForceVar.			
	None			
	Resource	resource test 1		
12	Control			
13	Time			

### 3.3. Delete Function

This functionality deletes one of the previously added functions in the sheet “Functions”. You have to select the function name corresponding to the function to be deleted, and then click on the button “Delete function”, which firstly generates a confirmation request. Note that the selected function will be deleted once accepted the confirmation request (the action cannot be undone).



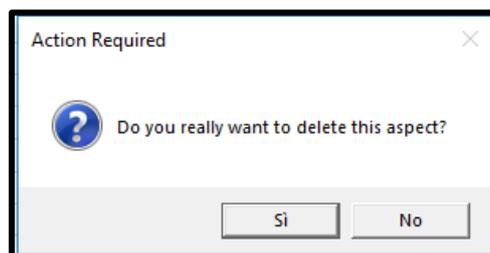
### 3.4. Add Aspect

This functionality adds extra aspects to any function, i.e, in case it may be necessary to have more than one Input, Output, Precondition, Resource, Control, Time. You have to put the cursor on the cell where the new aspect is needed and clicking on the button "Add Aspect". This latter creates a new row to be filled in and the row will be associated to the aspect (even if not presenting the label to support the visual analysis). For example, if an additional "Resource" is needed, you have to put the cursor in the row just below the label Resource (in a standard function with only 6 aspects, in the row associated with the label "Control"). The final situation will be as the one presented in the following figure (extra line in Resource).

	A	B	C	D
1				
2	Name of Function	TEST 1	GF	FP
3	Description			blue
4	Function Type			
5	None.			
6	None.			
7	Aspect	Description of Aspect		
8	Input	INPUT test 1		
9	Output	OUTPUT test 1		
10	Precondition			
11	Resource	RESOURCE test 1		
12				
13	Control			
14	Time			

### 3.5. Delete Aspect

This functionality deletes one of the previously added aspects in the sheet "Functions". You need to select the cell in the first column that corresponds to the row which containing the aspect to be deleted, and then click on the button "Delete Aspect". This latter generates a confirmation request. Note that the selected function will be deleted once accepted the confirmation request (the action cannot be undone).



You cannot delete anyone of the starting aspects, as for FRAM traditional formulation. If an aspect is not needed to describe a specific function, you have to leave it blank rather than deleting it.

### 3.6. Check Completeness

This functionality aims to identify potential unconnected Outputs in the model. Clicking on the button “Check Completeness”, myFRAM explores all the upstream/downstream connections, changing the font colour (to red) of those aspects that remain unconnected based on the information included in the sheet “Functions”. This functionality represents a support tool for the FRAM analysisist at verifying the closeness and the completeness of the model. This information will be translated into FMV, where the unconnected Outputs will be highlighted by a red circle.

	A	B	C	D
1				
2	<b>Name of Function</b>	TEST 1	GF	FP
3	<b>Description</b>			blue
4	<b>Function Type</b>			
5	<b>None.</b>			
6	<b>None.</b>			
7	<b>Aspect</b>	<b>Description of Aspect</b>		
8	<b>Input</b>	INPUT test 1		
9	<b>Output</b>	OUTPUT test 1		
10	<b>Precondition</b>			
11	<b>Resource</b>	RESOURCE test 1		
12	<b>Control</b>			
13	<b>Time</b>			

### 3.7. Export model (.pdf)

This functionality is thought to produce an automatic pdf report of the data included in the analysis (also including basic statistics) in a user-friendly representation. It is not implemented in the current version of myFRAM, but further information and updates will be made available [here](#) (update June 2018).

### 3.8. List Couplings

This functionality allows generating a tabular structured representation of upstream-downstream couplings in the sheet “Couplings”, depending on the information added in “Functions”. The scores associated to the variability (column J, K, i.e. Var.1, Var.2) refer the Output variability (as for the values assigned in the sheet “Empty Function”) and do not include the interaction variability or scenario variability [1]. Each coupling is uniquely addressed with a progressive index (C<sub>i</sub>, column L). A unique index for each function is also defined to support naming the couplings. Note that this functionality would also inherently shows those aspects that remains unconnected because no upstream Output has been provided: this scenario happens for those couplings with blank cells in the columns F:K (i.e. no data for upstream connection). This formal structure is also used to support future investigations based on quantitative or semi-quantitative analysis of variability (e.g. refer to [4]).

	A	B	C	D	E	F	G	H	I	J	K	L
1	Downstream function					Upstream function						
2	<b>Name of function</b>	<b>Description</b>	<b>#</b>	<b>Aspect</b>	<b>Description of aspect</b>	<b>Name of function</b>	<b>#</b>	<b>Function Type</b>	<b>Description of aspect</b>	<b>Var.1</b>	<b>Var.2</b>	<b>Couplings n°</b>
3	TEST 1	This is the description of TEST 1	1	Input	INPUT test 1	TEST 3	3	Organisational	INPUT test 1	1	1	C1
4	TEST 2	This is the description of TEST 2	2	Resource	RESOURCE test 1	TEST 2	2	Human	RESOURCE test 1	1	1	C2
5	TEST 2	This is the description of TEST 2	2	Input	OUTPUT test 1	TEST 1	1	Technological	OUTPUT test 1	1	1	C3

### 3.9. List Functions

This functionality lists all the functions defined in the model (i.e. in the sheet “Empty functions”), generating a synthetic representation of functional properties. The button “List Functions” will automatically generate a new sheet “Elements”, which will be automatically filled in with relevant information included in the sheet “Functions”. Note that the “Time Tag” (column F) refer to the Time Aspects defined in the sheet “Functions” for each function.

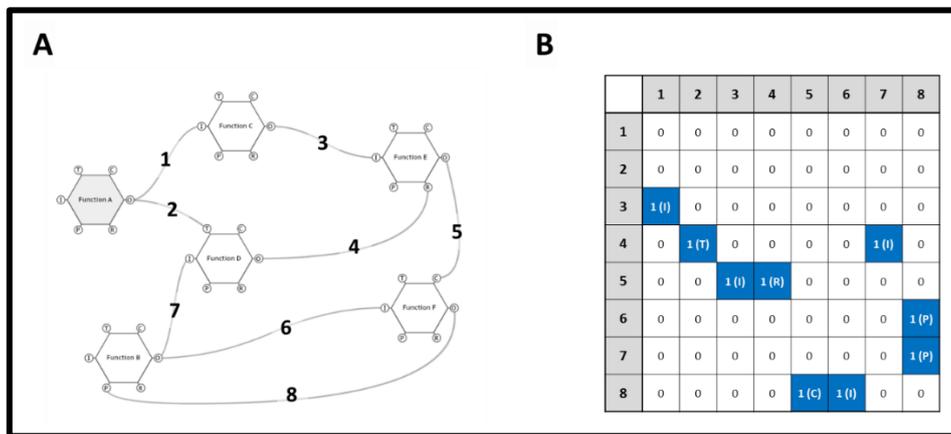
	A	B	C	D	E	F
1	<b>Function</b>	<b>Function Type</b>	<b>Description</b>	<b>Phenotype 1</b>	<b>Phenotype 2</b>	<b>Time Tag</b>
2	TEST 1	Technological	This is the description of TEST 1			
3	TEST 2	Human	This is the description of TEST 2			
4	TEST 3	Organisational	This is the description of TEST 3			

### 3.10. Generate RAM

This functionality is used to generate a matrix representation of the FRAM model, and consequently of the functional resonance potential, following the RAM (Resilience Analysis Matrix) approach presented in [5]. For the above mentioned example, myFRAM generates the following RAM, where the element  $RAM_{ij}$  assumes values 1 or 0: 1 if the coupling  $i$  is linked through upstream functions to the coupling  $j$ , then  $RAM_{ij} = 1$ , if not,  $RAM_{ij} = 0$ .

			TEST 1		TEST 2
Couplings n°			C1	C2	C3
C1	TEST 1	C1	0	0	0
C2		C2	0	0	1
C3	TEST 2	C3	1	0	0

A conceptual representation of the RAM structure is summarized in the following figure, comparing a traditional graphical-based representation of FRAM model (A) to a RAM-based representation of the same model (B).

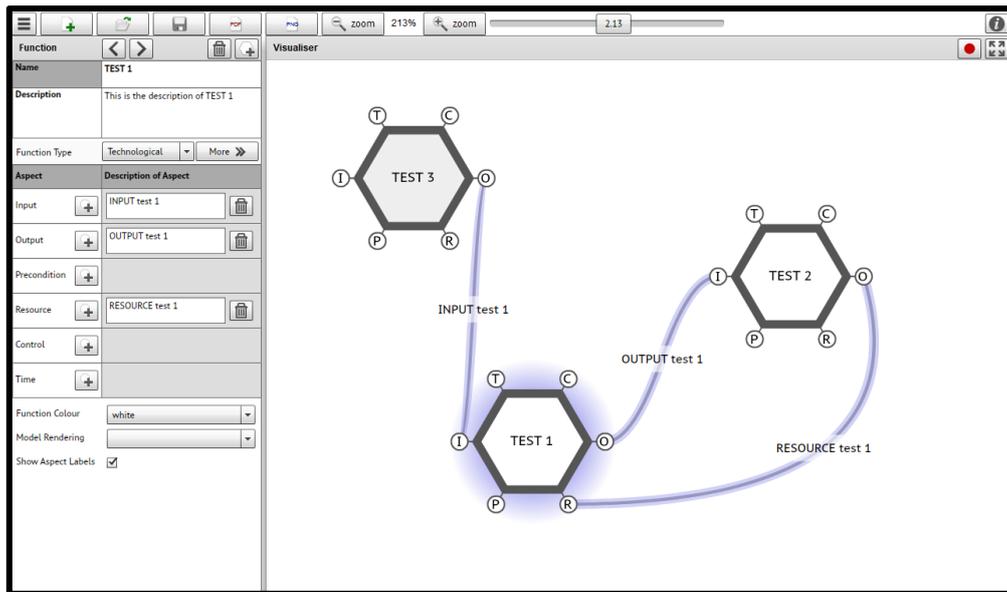


### 3.11. Export Graphical Model for FMV (.xmv)

This functionality refers to the possibility of exporting the FRAM model built in the sheet “Functions” into a FMV-friendly representation.

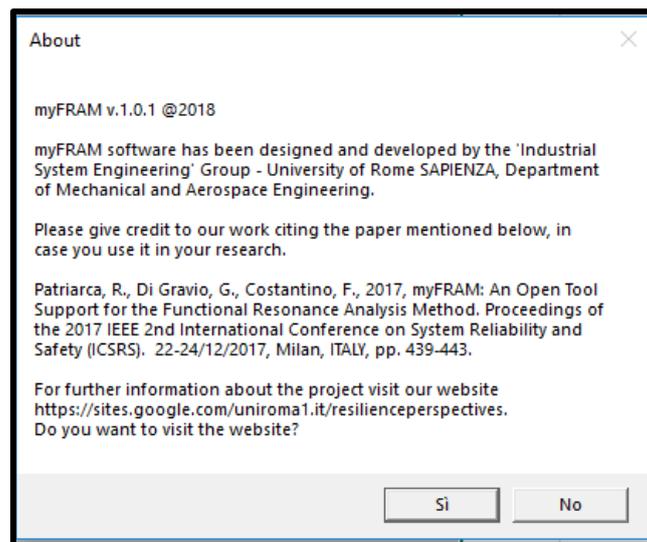
It is recommended to save the MS Excel file before clicking on the “Export Graphical Model for FMV (.xmv)” button and give it a name which is representative of the analysis being performed. Otherwise, if the MS Excel file has not been previously saved, after a confirmation request, myFRAM automatically saves it into the default saving directory (normally Documents). Afterwards, a message box asks for assigning the export path for the .xmv file. The outcome is a model completely visible in the FMV, offering all the standard functions (except for adding new aspects). You will be able to explore the inter-connections, move hexagons, showing aspect labels, change model rendering, record for playback, and even producing .pdf and .png reports (using traditional FMV functionalities).

However, note that the changes made in FMV will be stored in the .xmv file, but not transferred to the respective MS Excel file. As such, it is recommended to edit the model in the MS Excel file, in order to keep track of the changes.



### 3.12. About

The command “About” gives detailed information about the project and the scientific paper describing myFRAM development. It also automatically links to the website of the research group, which includes updates about myFRAM and other group’s activities.



## 4. End-User License Agreement (EULA) of myFRAM

This End-User License Agreement ("EULA") is a legal agreement between you and Costantino Francesco, Di Gravio Giulio, Patriarca Riccardo (hereinafter: Licensor).

This EULA agreement governs your acquisition and use of our myFRAM software ("Software") directly from Licensor or indirectly through a Licensor authorized reseller or distributor (a "Reseller").

Please read this EULA agreement carefully before completing the installation process and using the myFRAM software. It provides a license to use the myFRAM software and contains warranty information and liability disclaimers.

If you register for a free trial of the myFRAM software, this EULA agreement will also govern that trial. By clicking "accept" or installing and/or using the myFRAM software, you are confirming your acceptance of the Software and agreeing to become bound by the terms of this EULA agreement.

If you are entering into this EULA agreement on behalf of a company or other legal entity, you represent that you have the authority to bind such entity and its affiliates to these terms and conditions. If you do not have such

authority or if you do not agree with the terms and conditions of this EULA agreement, do not install or use the Software, and you must not accept this EULA agreement.

This EULA agreement shall apply only to the Software supplied by Licensor herewith regardless of whether other software is referred to or described herein. The terms also apply to any Licensor updates, supplements, Internet-based services, and support services for the Software, unless other terms accompany those items on delivery. If so, those terms apply.

#### *License Grant*

Licensor hereby grants you a personal, non-transferable, non-exclusive licence to use the myFRAM software on your devices in accordance with the terms of this EULA agreement.

You are permitted to load the myFRAM software (for example a PC, laptop, mobile or tablet) under your control. You are responsible for ensuring your device meets the minimum requirements of the myFRAM software. You are not permitted to:

Edit, alter, modify, adapt, translate or otherwise change the whole or any part of the Software nor permit the whole or any part of the Software to be combined with or become incorporated in any other software, nor decompile, disassemble or reverse engineer the Software or attempt to do any such things

Reproduce, copy, distribute, resell or otherwise use the Software for any commercial purpose if not under these conditions: myFRAM is provided free of charge and must not be sold for commercial purposes in either the original or a repackaged form.

Allow any third party to use the Software on behalf of or for the benefit of any third party

Use the Software in any way which breaches any applicable local, national or international law

use the Software for any purpose that Licensor considers is a breach of this EULA agreement

#### *Intellectual Property and Ownership*

Licensor shall at all times retain ownership of the Software as originally downloaded by you and all subsequent downloads of the Software by you. The Software (and the copyright, and other intellectual property rights of whatever nature in the Software, including any modifications made thereto) are and shall remain the property of Licensor.

Licensor reserves the right to grant licences to use the Software to third parties.

#### *Termination*

This EULA agreement is effective from the date you first use the Software and shall continue until terminated. You may terminate it at any time upon written notice to Licensor.

It will also terminate immediately if you fail to comply with any term of this EULA agreement. Upon such termination, the licenses granted by this EULA agreement will immediately terminate and you agree to stop all access and use of the Software. The provisions that by their nature continue and survive will survive any termination of this EULA agreement.

#### *Governing Law*

This EULA agreement, and any dispute arising out of or in connection with this EULA agreement, shall be governed by and construed in accordance with the laws of ITALY.

## References

- [1] E. Hollnagel, FRAM: The Functional Resonance Analysis Method - Modelling Complex Socio-technical Systems. Ashgate, 2012.
- [2] E. Hollnagel, R. Hill. "Instructions for use of the FRAM Model Visualiser (FMV). Available at <http://functionalresonance.com/tools-visualisation/fram-visualisation.html> (date accessed 9th June 2018).
- [3] R. Patriarca, J. Bergström, and G. Di Gravio, "Defining the Functional Resonance Analysis space: combining Abstraction Hierarchy and FRAM," Reliab. Eng. Syst. Saf., vol. 165, no. February, pp. 34-46, 2017. <https://doi.org/10.1016/j.ress.2017.03.032>
- [4] R. Patriarca, G. Di Gravio, F. Costantino, "A Monte Carlo evolution of the Functional Resonance Analysis Method (FRAM) to assess performance variability in complex systems". Safety Science, vol. 91, pp. 49-60. 2018. <https://doi.org/10.1016/j.ssci.2016.07.016>
- [5] R. Patriarca, G. Del Pinto, G. Di Gravio, and F. Costantino, "FRAM for systemic accident analysis: a matrix representation of functional resonance," International Journal of Reliability, Quality and Safety Engineering, vol. 25, no. 1, 2018. <https://doi.org/10.1142/S0218539318500018>

If you use myFRAM for your FRAM analysis, please give credit to our work citing our conference paper about myFRAM design and concept idea:

Patriarca, R., Di Gravio, G., Costantino, F., "myFRAM: An open tool support for the functional resonance analysis method," *2017 2nd International Conference on System Reliability and Safety (ICSRS)*, Milan, 2017, pp. 439-443. doi:10.1109/ICSRS.2017.8272861