

FEM toolkit version 1.1 and FEM viewer – What is new?

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Abstract

The paper presents the latest development in modeling tools that support the development and usage of Fractal Enterprise Models (FEMs). It describes the new features in the latest version of FEM toolkit – a software tool that facilitates the development of FEMs, which is built using the ADOxx environment, and presents a new tool – FEM viewer. The latter is a web-based tool that allows non-modeling stakeholders to study and navigate through a package of interconnected FEMs using a simple, but powerful user interface.

Keywords

Fractal Enterprise Model, FEM Toolkit, FEM viewer, ADOxx

1. Introduction

Fractal Enterprise Model (FEM) [1] is a modeling technique that presents an enterprise as a set of interconnected activities, and, at the same time, has a resource-oriented view on the enterprise. FEM toolkit [2] is software that supports building a package of FEM diagrams that represents the enterprise environment, its activities and resources (called assets in FEM), and interconnections between these elements. The FEM toolkit is built using ADOxx environment [3]; it is available for free download from [4]. It runs in a Windows environment, and it can be used on MAC OS and Linux using virtual Windows machines.

This paper presents the latest version of the FEM toolkit, called FEM toolkit 1.1. The version includes a number of new features, not described in the earlier papers devoted to FEM toolkit, such as [2]. In addition to the *FEM toolkit*, a new tool called the *FEM viewer* was developed. *FEM viewer* is a web-based tool to view and browse through a set of interconnected FEM diagrams. It has a very simple WEB interface, so that business stakeholders can easily use it. A modeler exports their models from the FEM toolkit and then imports them into the FEM viewer. Imported models can be shared with business people, who do not need to understand how to build them. The viewer does not only allow to see the model, but it also has means for navigating through the interconnected set of models.

In this paper, we give a short overview of FEM, and the FEM toolkit, and present the new features of the latter. Additionally, we will present the basic concepts of the FEM viewer in more detail. Readers who want to have a more detailed review of the FEM toolkit features that existed in previous versions are referred to paper [2], and to the FEM website [5].

2. Fractal enterprise model – short overview

As FEM is not widely used, we provide some necessary (but not all) details on what it entails. To do that, we will use an example of a hospital that performs surgical operations. The FEMs for this case are presented in Fig. 1 and Fig. 2, where Fig. 1 gives a general picture, and Fig. 2 adds some details to it.

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FEM was developed as a modeling language and notation for representing operational activities of an organization. The basic version of FEM has two main concepts - *process* and *asset* - and two types of relations between them – *used in* and *managed by*.

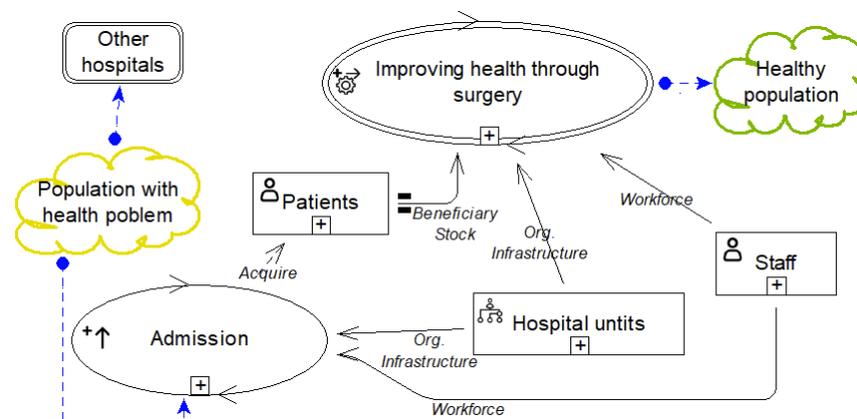


Figure 1: An overall model for the example

A *used in* relation between a process and asset means that the asset plays a certain role in the process. The relation is visually represented by an arrow with a solid line that goes from the asset to the process (see Fig. 1, 2). A *managed by* relation between an asset and a process means that the process changes the set, i.e. adds or removes elements or changes their properties (see Fig. 1,2). The relation is visually represented by an arrow with a dashed line that goes from the process to the asset. A label is added to the relation to identify which role the asset plays in the process, or how the process changes the asset. The set of labels is standardized; more exactly, there are 8 labels that can be added to a *used in* relation and three labels that can be added to a *managed by* relation, namely *Acquire*, *Maintain* and *Retire*.

Assets and processes can be presented on different levels of granularity. If needed, a connection between different granularity levels can be expressed with the help of decomposition. As an *asset* is a set of things, its decomposition means splitting the set into subsets. For the *process*, which represents behavior, decomposition can be of two types: (1) specialization – elements of the decomposition represent concrete versions of generic behavior; (2) part of – elements of decomposition represent parts of the decomposed behavior. Visually, decomposition is presented via placing elements of the decomposition inside the border of the decomposed element. In this case, the shape of the decomposed element changes to a rectangle with rounded corners; the border also changes from a solid line to a dashed or dotted line. The dashed border is used for decomposing assets or decomposing processes – behavior – using a *specialization* decomposition. The dotted border is used for decomposing a process using a *part of* decomposition. An example of asset decomposition and *part of* decomposition for a process are presented in Fig. 2.

At the root of Fig. 1 is a primary process called *Improving health through surgery*. To run it repeatedly, the process needs some assets, three types of which are presented in the model: *Patients*, *Staff*, and *Hospital*. The roles they play in the process are on the respective arrow; they are chosen from a fixed set. As we can see, an asset can play more than one role in the process. For example, *Patients* play two roles, *Beneficiary*, and *Stock*. *Stock* is a special role that means that each time an instance of behavior is activated, one or several elements from the *Stock* asset are consumed by the behavior. The latter means that the asset needs constant filling. This is not true for other types of assets, e. g. *Workforce*, as it is not being depleted each time an instance of the behavior is activated.

To constantly fill the asset *Patients*, the model in Fig. 1 has an additional managerial process (behavior) called *Admission* that adds new elements to the asset. Other processes also need managerial

processes to have the assets in “working order”, but we will not go into this level of detail in the paper.

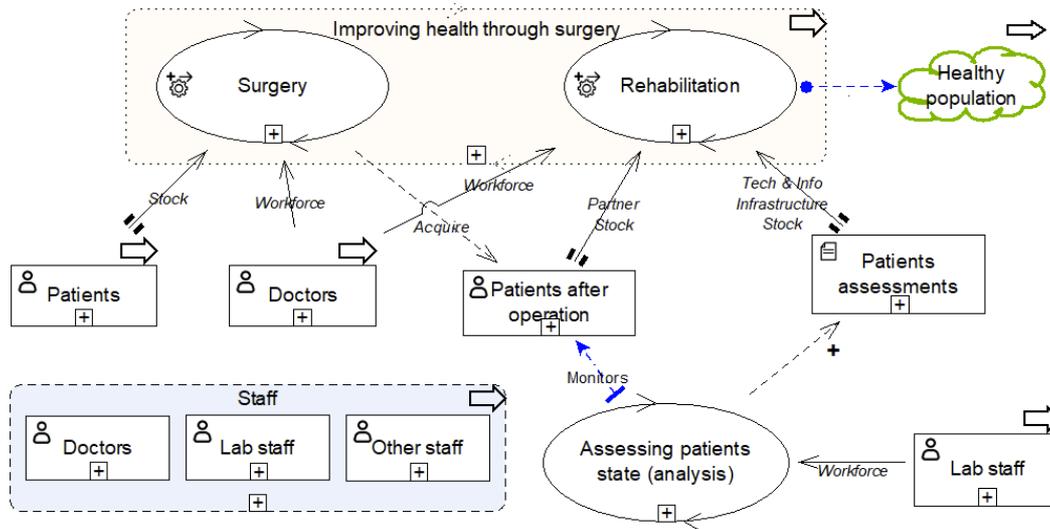


Figure 2: Adding details

FEM toolkit allows to connect models in a package using a special *Ghost* feature. A *ghost* represents the second, third, etc., occurrence of a shape that has already been introduced in some model of the package. The ghost has a thick arrow in the top right corner of the shape, clicking on which will move the focus to the ghost’s original. The ghost feature was used to connect the model in Fig. 2 to the model of Fig. 1.

The model in Fig. 2 decomposes the primary process into two subprocesses: *Surgery* and *Rehabilitation*. There is also a decomposition of the asset *Staff* to identify categories of employees that are needed for a more detailed model: *Doctors* and *Lab staff*. The subprocesses *Surgery* and *Rehabilitation* are connected via the asset *Patients after operation*. *Surgery* functions as an *Acquire* process for the asset *Patient after operation*, adding a new element to it each time a surgery operation is completed. The asset *Patients after operation* is also connected by a *used-in* relation to *Rehabilitation*. The arrow that represents the relation has two labels: (1) *Stock*, which means that the element of the asset disappears after rehabilitation has been completed, and (2) *Partner*, which means that this asset actively participates in the process, engaging in care activities while not being part of the hospital organization.

Both *Surgery* and *Rehabilitation* use *Doctors* as *Workforce*, which means that a Doctor is an active agent that belong to the organization. *Rehabilitation* uses one more asset *Patient assessments*, that contains data on the health state of the rehabilitating patients. The label is marked as *Tech & Info Infrastructure*, which means that it is used as information for decision making, and *Stock* – the information is consumed by the process and new information needs to be added. To add elements to *Patient assessments*, an additional process - *Assessing patient’s state (analysis)* – is added. It uses *Lab staff* as *Workforce*, and it monitors the state of the patient (special relation described in Section 3.1); patients are (relatively) passive during the assessment.

Readers who are interested to know more about FEM, and why it has the word fractal in its name are referred to paper [1].

3. What is new in FEM toolkit version 1.1?

In this section, we describe the most important features that have been introduced in the new versions of FEM toolkit based on our experience of using the toolkit in practice and in the educational context.

These features are not presented in the articles devoted to FEM and FEM toolkit, such as [2]. In particular, the new version includes:

1. New relations: Inspects/Monitors and Association. Inspects/Monitors connects an activity to an asset or any other element to show that the activity investigates this element without the goal of changing it. A normal output of this activity is information about the investigated element. Association connects two model elements that are related to each other, but the semantics of the relation does not correspond to the standard FEM relations.
2. The possibility to add icons to better visualize the meaning of assets and actions.
3. Optionally using symbols +, – or ~ instead of the Acquire, Retire or Maintain labels
4. Possibility to define classes via border coloring, in addition to the possibility of defining classes via background coloring. Both can be applied to any element of the model.
5. Differentiation between the basic and advanced modes, where the advanced mode includes additional features not available in the basic mode.
6. Constraints that prevent the creation of semantically incorrect models. They can be overridden, if needed, e.g., when defining patterns rather than building actual models.
7. Translation of standard labels on arrows to other languages.

The following subsections describe the above features in more detail.

3.1. New relations

Two new relations were introduced in a new version of FEM and FEM toolkit: *Inspects/Monitors* and *Association*, see Fig. 3. The first relation connects a process with any other elements of the model, i.e. process, asset, pool, or external actor. The process, in this case, exhibits an observing behavior, i.e. gathering information from the observed with no or minimum intervention with it. Visually, this relation is represented by an arrow with a dash-dotted blue line; it also has a small rectangular tail. The tail points to the observing process, the arrow points to what it observes. A label in the form of free text can be added to specify the nature of the relation. This relation is used in the model of Fig. 2. The rationale for adding this relation has been to be able to represent activities of system 3* of the viable system model (VSM) [6]. However, it can be used for other purposes as well. One example of usage is discussed in [7], other examples are discussed in the forthcoming work [8].

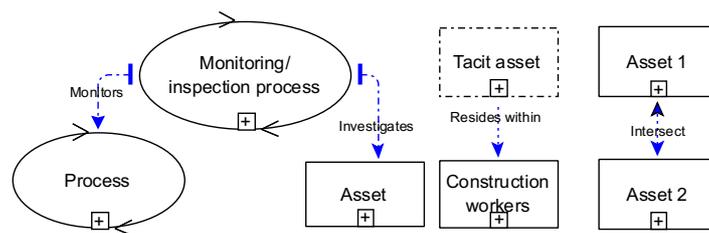
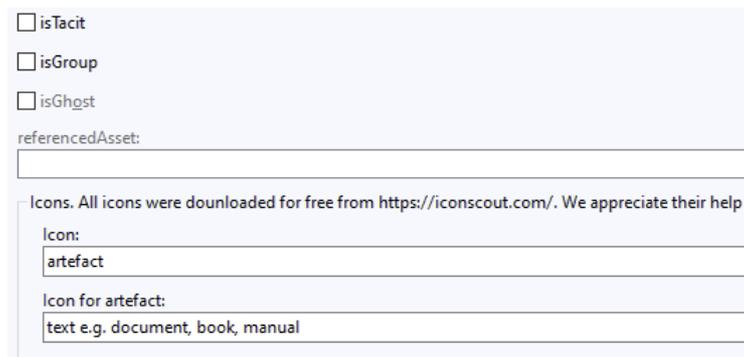


Figure 3: New relations

The relation *Association* does not have any definite meaning; it is used whenever there is a need to express something that is not possible to express with other relations. Visually, it is represented by an arrow with a blue dotted line. This relation can be symmetrical – an arrowhead on both ends, or asymmetrical – an arrowhead only on one end. The meaning of the relation is explained using a free text label. The rationale for adding this relation has been to enable representing additional connections between the model elements that are not covered by specific relations.

3.2. Icons for assets and process shapes

As can be seen in Fig. 1 and 2, some of the process and asset shapes have icons that visualize the content of the asset, or the meaning of the process. For example, assets *Patients* and *Doctors* have icons that show that the assets consist of people. FEM toolkit includes a set of icons that can be chosen based on the needs. The choice is done when setting attributes of a shape, as shown in Figure 4, which illustrates the icon that has been chosen for the asset *Patients assessments* in Fig. 2. The rationale for adding icons has been to make it easier to grasp the model without reading text labels inside the shapes.



isTacit
 isGroup
 isGhost

referencedAsset:

Icons. All icons were downloaded for free from <https://iconscout.com/>. We appreciate their help

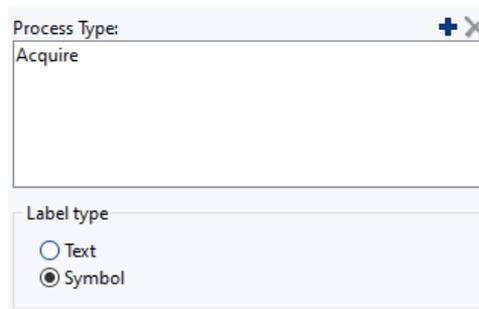
Icon:
artefact

Icon for artefact:
text e.g. document, book, manual

Figure 4: Setting icons

3.3. New way of marking the managed by relations

Text is the standard way of showing the label on a *managed by* relation. To make the model more visual, and less cluttered, the new version of the FEM toolkit makes it possible to show a symbol instead of a textual label for *Acquire*, *Retire* or *Maintain*. This is done by a special attribute of the relation, as shown in Figure 5. Choosing *Symbol* will substitute the label *Acquire* to the “+” sign, as shown in Fig. 2 for the relation between the process *Assessing patients state (analysis)* and the asset *Patients assessments*. For the *Retire* relation, the symbol would be “-”, and for *Maintain*, it would be “~”. Note that if there is more than one label on a relation, choosing “Symbol” would not have any effect. The rationale for the symbolic representation of some labels on the relations has been to make the models less cluttered with text labels.



Process Type: + X

Acquire

Label type

Text
 Symbol

Figure 5: Setting symbolic representation of managed by relations

3.4. Defining classes via border coloring

In the new FEM toolkit, it is possible to define subclasses of FEM concepts that will be shown in a model via border coloring. This is illustrated in Fig. 1, where one of the pools has a yellow border color, and the other – a green border color. The meaning of this coloring is defined in a special sheet – a model of the type *Border Subclassing*. An example of such a model is presented in Fig. 6, left side.

This sheet is then used for defining the border color of FEM components, as shown in Fig. 6, right side. The latter shows how the pool *Healthy population* in Fig. 1 gets the green border.

The new subclassing is, in addition to the already existing way of defining subclasses by assigning a background color. The border subclassing is independent from the background subclassing. The latter means that an individual concept can be classified from two independent points of view. The need for subclassing is discussed in [9]. The new feature just adds a possibility to have two different dimensions so that the same element could be classified in each of them separately.

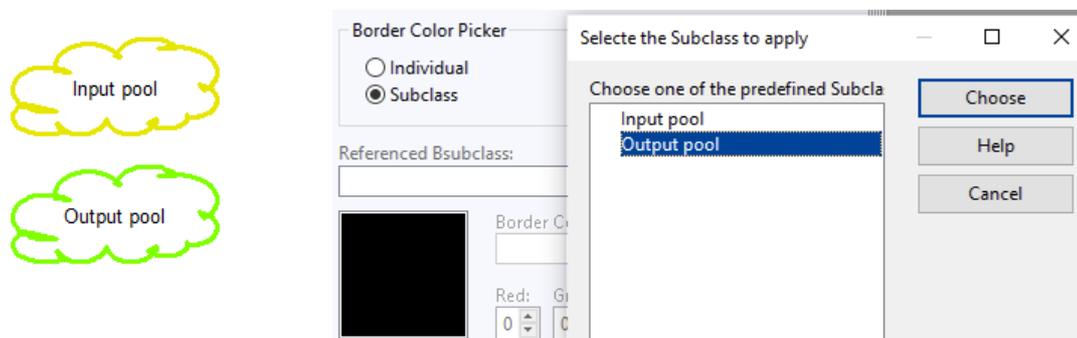


Figure 6: Setting a subclass for the pool *Healthy population* in Fig. 1. (a) To the left – subclass definition. (b) To the right – assigning a subclass to the pool

3.5. Separation between basic and advanced mode

In the latest version of FEM toolkit, the model can be developed in one of two modes: *Basic* and *Advanced*. By default, a new FEM model is created in a basic mode. The latter includes only two concepts – process and asset – and two types of relations – *used in* and *managed by*. An advanced mode includes two additional concepts – external pool and external agent – and three additional relations – *Drawing/Adding*, *Inspect/Monitors* and *Association*. It is easy to switch from one to another. Switching from the basic to advanced mode results in new elements being added to the modeling panel window. Switching from the advanced mode back to basic will remove these elements. If no advanced elements exist in the model, the model remains the same. If the advanced elements have been added to the model, they are greyed and become non-accessible (until switching back to the advanced mode). The rationale for adding this feature has been to make it easy for a newcomer to learn FEM.

3.6. Semantic constraints

The latest version of FEM introduces some constraints that ensure the semantic correctness of the model under construction. An example of such constraints is presented in Fig. 7. If an asset is used in one process as *Workforce*, it cannot be used as *Tech & Info infrastructure* in another or the same process. If a modeler tries to do this, he will get an error as shown in Fig. 7. Most of the constraints are related to a combination of labels on the same relation or on relations related to the same modeling element, see full list of such constraints in [10]. These constraints might not be very important for an experienced modeler, who fully understands the concepts of FEM. However, they are quite useful in the educational context when FEM is used by novices.

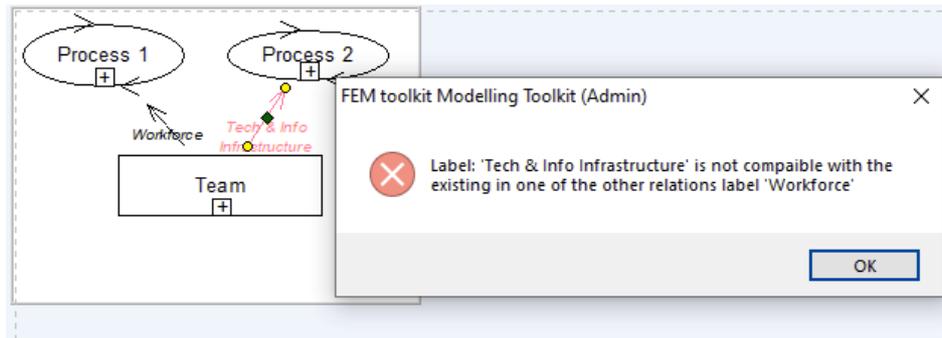


Figure 7: An example of semantic constrains

3.7. Translation of labels

Labels on the *used in* and *managed by* relations are standardized, and they have English names. In Version 1.1 of toolkit it is possible to supply a translation file, where some, or all labels are changed, e.g. presented in another natural language. A translation file can be uploaded and activated or deactivated. Activation/deactivation allows the developers to work with the standard English labels but show the models to the stakeholders with the translated labels on the relations.

4. FEM viewer

FEM toolkit is a tool aimed at modelers. It is not always easy to install FEM toolkit, especially on non-Windows machines, and using it requires some skills, even just for browsing through the set of already created models. Thus, giving this tool to the non-modeling stakeholders does not work for everyone.

An alternative method of providing stakeholders with a package of models as printed PDF sheets has its own drawbacks. While you can easily investigate an individual model, the possibility of going from one model to another using the ghost feature is lost. FEM viewer is designed to solve the problem of providing non-modeling stakeholders with a convenient method of studying the models on their own.

FEM viewer is a web-based tool that gives a possibility for its users to browse through a set of interconnected FEMs in an easy manner. The package of models can be exported from the FEM toolkit, and imported in the FEM viewer. After that, a user or group of users can be given access to the package. The user can easily browse through the set of models following the links connecting the models. An example of a package and the way a user can browse through it is presented in Fig. 8.

FEM viewer has three different kinds of users: *administrator*, *developer*, and *viewer*. An administrator can create new users and give them credentials. A developer can upload new models and create new users of the viewer type, and give them access to the uploaded models. Viewers can only view the model that they have been assigned to.

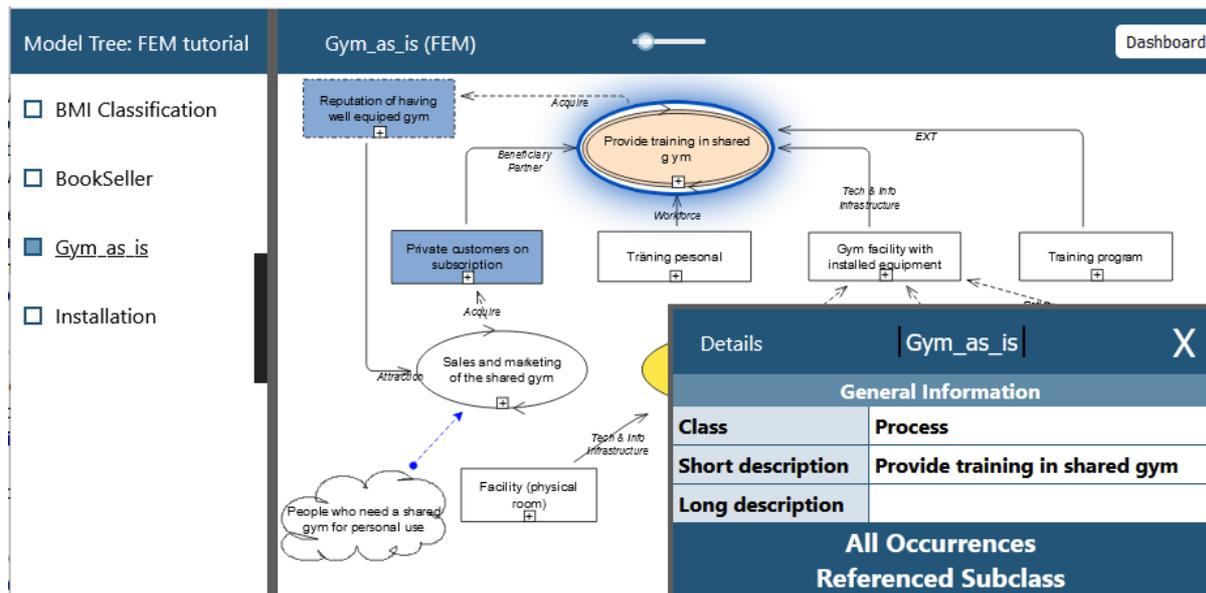


Figure 8: FEM viewer

5. Testing FEM toolkit

More information on FEM and FEM toolkit is available in [1], [2] and especially [5]. These materials are freely accessible, except [2], but there is a free version on Research Gate for it https://www.researchgate.net/publication/359152624_Tool_Support_for_Fractal_Enterprise_Modeling. The FEM toolkit can be freely downloaded from [4]. Windows installation is straightforward. However, for Mac or Linux, there can be problems in installing MS SQL server in their virtual environment. ADOxx team has just released a new 64-bit version of ADOxx environment, in which these problems are, hopefully, solved.

There are several recorded materials about FEM/FEM toolkit on the website [5]. A shorter introduction (4 min) is available at <https://www.fractalmodel.org/FEMintroduction.mp4>. One of the new features – Basic/Advanced mode – is illustrated in a short (3min) video: <https://www.fractalmodel.org/NewToolkitModes.mp4>.

6. Plans for the future

There are no immediate future plans for the FEM toolkit. Regarding FEM viewer, there are plans to extend its functionality, so that the user can provide feedback when browsing through the package of models. The feedback could be brought back to the FEM toolkit.

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