

# Expectations of Formal Model Analysis Methods: Implications for SIG-MA

Jill H Slinger

Delft University of Technology, Jaffalaan 5, 2628 LS Delft, Netherlands

## Abstract

At the 2008 System Dynamics Conference in Athens a survey of the understanding and expectations of conference participants regarding model analysis was conducted. Respondents included both those active in research on formal model analysis methods and those only vaguely familiar with the term. Results from the survey are presented and discussed and the implications for the Special Interest Group on Model Analysis (SIG-MA) explicated.

## Key words

Perceptions of formal model analysis, communicating model understanding, model behavior, Special Interest Group, System Dynamics

## Introduction

The Special Interest Group on Model Analysis (SIG-MA) focuses on the development, use and advancement of formal model analysis methods in System Dynamics. These methods currently include: Pathway Participation Metric (Mojtahedzadeh 1997, Mojtahedzadeh et al. 2004), Ford's Behavioural Analysis (Ford 1999) and Eigenstructure-based methods (Kampmann 1996; Saleh 2002, Kampmann and Oliva 2005, Guneralp 2005, Saleh 2005), amongst others. Recently, much attention has focussed on comparing the outcomes of the different methods and evaluating their contributions in the field of System Dynamics (Phaff et al. 2006, 2007, Mojtahedzadeh 2008, Kampmann and Oliva 2008). The SIG-MA was initiated in 2007 and its activities include facilitating communication amongst model analysts by moderated listserve discussions ([sdsigma@listserve.tudelft.nl](mailto:sdsigma@listserve.tudelft.nl)). These have focused primarily on theoretical developments and the exchange of opinions on recent publications. However, the members of the special interest group considered a clear understanding of the opinions of the wider System Dynamics community necessary, before deciding on the future direction and activities of the SIG-MA. They wanted to know how their professional colleagues regarded formal model analysis methods. Was anyone actually interested in this field besides the committed core of SIG-MA? To answer these and other questions, a questionnaire was developed and a survey of a number of System Dynamicists was undertaken. The survey-based insights regarding the expectations and perceptions that colleagues from the System Dynamics community hold of formal model analysis, are reported in this paper.

## Method

To assist in determining the direction and activities of the Special Interest Group on Model Analysis, a number of participants at the International System Dynamics Conference in Athens in July 2008 were canvassed regarding their opinions, knowledge and use of formal

model analysis methods. They were requested to complete a questionnaire giving their ideas and opinions on the value of formal model analysis methods, how these assisted them (or not) and how the value of these methods to them could be enhanced. Fourteen respondents voluntarily completed the questionnaire. The questionnaire comprised eleven questions, five of which allowed differentiation in the answers between different formal analysis methods (Appendix 1). The methods of Ford's behavioural analysis (hereafter termed Ford), the Pathway Participation Metric (PPM) and the Eigenstructure-based methods e.g. Eigenvalue Elasticity Analysis (EEA) are mentioned specifically, although the option of answering generally for all formal model analysis methods or specifying another method is also given.

Of the 14 respondents, five were consultants (1 of whom also does some research), seven were academics (3 of whom also undertake consultancy work) and two were phd students/post graduates. Three of the respondents had less than two years experience with System Dynamics (2 consultants and one post graduate). Six people had more than 10 years System Dynamics experience (primarily the academics, one consultant). There were three people with 2 to 5 years experience and 2 with 5 to 10 years experience. Twelve of the fourteen used System Dynamics daily or frequently, the other 2 only occasionally.

## Results

### *Familiarity with formal model analysis*

Only two of the respondents have used formal model analysis methods personally, although eight out of the fourteen have used some formal model analysis methods occasionally. In response to the question on which methods they had heard of or used, ten of the respondents indicated the Eigenstructure-based methods, six Ford's behavioural analysis and four the Pathway participation metric.

The spread in the expertise of the respondents and their widely divergent familiarity with formal model analysis methods means that although the number of respondents is limited, they represent a wide cross section of the System Dynamics community.

### *Advantages in adopting formal model analysis methods*

Nine of the fourteen respondents answered this part of the questionnaire without specifying particular formal model analysis methods. Two people referred specifically to EEA and one to Ford. Only one of the people who uses formal model analysis personally, specified for both the PPM and EEA. In doing so, they revealed a deeper appreciation of the capacities of the specific methods, but conformed to the pattern of voting of the rest of the respondents.

Eleven of the fourteen respondents have the expectation that these methods will help to identify the most influential parts of a model (Table 1). Deeper understanding of a model and help in formulating and testing policies received ten votes apiece. Eight of the fourteen respondents anticipated a better explanation of how structure drives behaviour. Finally, other potential uses such as in building a model, simplifying a model or communicating with clients all received 6 votes apiece.

### *Disadvantages in adopting formal model analysis methods*

Eleven of the fourteen respondents completed this part of the questionnaire without specific reference to particular formal model analysis methods. One gave specific answers for the

EEA methods and two for both PPM and EEA. The lack of automation of the EEA received specific attention.

The major perceived disadvantages in adopting or using formal model analysis methods lie in the lack of automation and that they are not included in standard software packages. Each of these categories received nine votes apiece (Table 1). The difficulties in using the methods and in explaining to a client were also perceived as serious obstacles, with each receiving seven votes. The category 'methods are difficult to understand' received six votes. Interestingly, four of the five consultants indicated 'takes too much time' as a disadvantage.

### *Improving the formal model analysis methods and their use*

Two of the respondents, both very experienced System Dynamicists, specified their answers per formal model analysis method. The rest answered generally. The only differences in the specific and general voting were that the need to improve the theory underpinning the EEA methods was pinpointed.

The activity that received the most attention was 'Provide examples of methods (tutorials)'. This received ten votes and was closely followed by 'improve method visualisation' with nine votes (Table 1). Next, improving the understandability of the output and supplying guidelines for communicating using the methods each received eight votes as did the need to develop the underpinning theory further. The activity 'automate the methods' only received seven votes, although the lack of automation was perceived as a major disadvantage in adopting and using formal model analysis methods.

## Implications for the Special Interest Group on Model Analysis

In responding to the questions on the value and use of formal model analysis and how this can be improved, System Dynamicists place the emphasis on how to **use** formal model analysis methods **themselves** and how to **explain and demonstrate** results. This is evidenced by their strong preference for tutorials, method visualization and guidelines for communicating as opposed to automation in spite of the view that the lack of automation is the greatest disadvantage. The advantages perceived by the the System Dynamics community include identifying the most influential parts of a model, deeper understanding of a model and help in formulating and testing policies, confirming this insight.

One of the respondents commented 'These methods have a relatively steep learning curve. The SIG needs to make accessible the literature more easily to those wanting to learn them. How about a 'road map' series for model analysis?', presenting the collective opinion of the respondents in a nutshell.

This message needs to be taken seriously by the SIG-MA and used in its prioritization of tasks.

Table 1: Summarized of the results of the questionnaire

<b>What value do you see for yourself in adopting these methods?</b>	1 to 3			4 to 6			7 to 9			10 to 12		
Better explanation of how structure drives behaviour												
Helps to identify most influential parts of a model												
Helps in simplifying a model												
Helps in communicating with clients												
Helps in building a model												
Deepens understanding of a model												
Helps in formulating and testing policies												
<b>What disadvantages do you see for yourself in adopting these methods?</b>												
Methods are difficult to understand												
Difficult to use												
Not automated, not included in standard software												
Difficult to explain to client												
Difficult to understand the output												
Takes too much time												
<b>How could the methods and their use be improved?</b>												
Underpinning theory needs further development												
Automate the methods												
Improve the understandability of the output												
Improve method visualisation												
Readily available software												
Provide examples of methods (tutorials)												
Guidelines for communicating using the methods												

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Appendix 1: Questionnaire

Special Interest Group for Model Analysis (SIG-MA)

Questionnaire  
July 2008

The Special Interest Group for Model Analysis is interested in your ideas and opinions on the value of formal model analysis methods, how these assist you (or not) at present and how their value to you can be enhanced. Please fill in this questionnaire so that you can help us in improving formal model analysis methods and their use.

- 1 Name
- 2 Job description
- 3 Years of experience with SD models and modeling?  
 < 2       2 – 5       5 -10       >10
- 4 How would you describe your SD involvement? (more than one answer possible)  
 consultancy    teaching    research    client
- 5 How often do you use SD in your current job?  
 daily    frequently    occasionally    never
- 6 How familiar are you with formal model analysis methods?  
 Never heard of them (go directly to question 8)  
 Know about them, but have never used them personally  
 Use some methods occasionally  
 Regularly use formal model analysis methods  
 Involved in the further development of these methods
- 7 Indicate which of the following methods you have heard of, or used?  
 Ford's behavioural analysis (Ford)  
 Pathway participation metric (PPM)  
 Eigenstructure-based methods e.g. eigenvalue elasticity analysis (EEA)  
 Other (please describe.....)

8 What value do you see for yourself in adopting/using these methods? (Use the first column if you do not wish to specify your answer per method, more than one answer is possible per column)

All	Ford	PPM	EEA	Other	
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Better explanation of how structure drives behaviour
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Helps to identify most influential parts of a model
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Helps in simplifying a model
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Helps in communicating with clients
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Helps in building a model
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Deepens understanding of a model
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Helps in formulating and testing policies
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Other (please describe.....)

9. What disadvantages do you see for yourself in adopting/using these methods? (Use the first column if you do not wish to specify your answer per method, more than one answer is possible per column)

All	Ford	PPM	EEA	Other	
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Methods are difficult to understand
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Difficult to use
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Not automated, not included in standard software
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Difficult to explain to client
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Difficult to understand the output
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Takes too much time
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Doesn't add value to the model analysis I currently do
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Other (please describe.....)

10 How could the methods and their use be improved? (Use the first column if you do not wish to specify your answer per method, more than one answer is possible per column)

All	Ford	PPM	EEA	Other	
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Underpinning theory needs further development
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Automate the methods
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Improve the understandability of the output
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Improve method visualization
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Readily available software
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Provide examples of methods (tutorials)
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Guidelines for communicating using the methods
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Other (please describe.....)

11 Additional comments