Modeling and Analysis Overview

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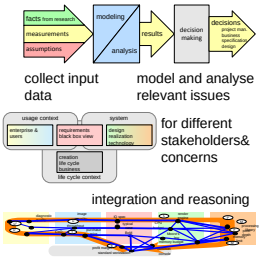

Gerrit Muller
HSN-NISE
Hasbergsvei 36 P.O. Box 235, NO-3603 Kongsberg Norway
gaudisite@gmail.com

Abstract

The course Modeling and Analysis is described. The program consists of 10 modules. The course format, iterating theory, illustration and interaction is explained. The course heavily emphasizes the practical application of the method. This presentation shows the overview of the modeling and analysis approach and the methods and techniques that will be elaborated in the rest of the course.

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1 Introduction

At the beginning of the creation of a new product the problem is often ill-defined and only some ideas exist about potential solutions. The architecting effort must change this situation in the course of the project into a well articulated and structured understanding of both the problem and its potential solutions. Figure 1 shows that basic methods and an architecting method enable this architecting effort. We will zoom on modeling and analysis as support for the architecting effort.

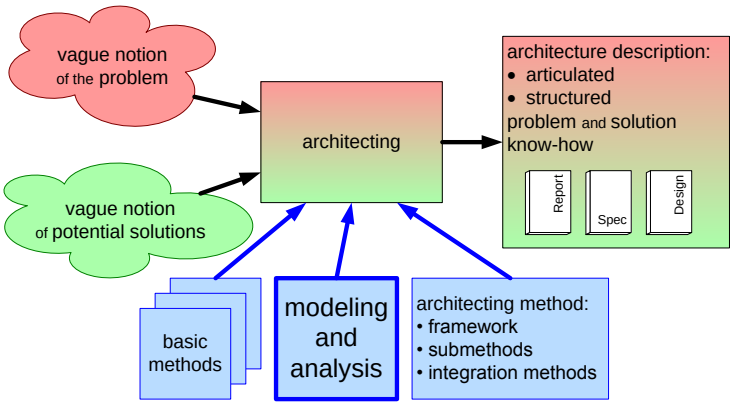

Figure 1: An architecting method supports the architect in his process to go from a vague notion of the problem and a vague notion of the potential solutions to a well articulated and structured architecture description. Modeling and Analysis supports the architecting effort.

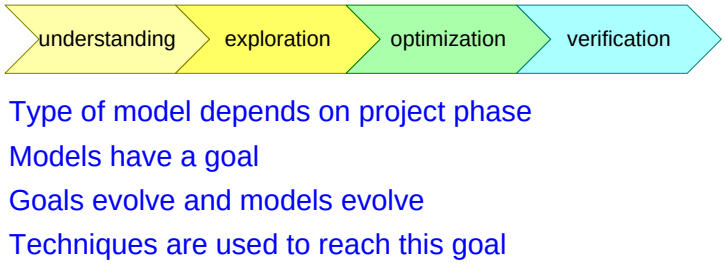

Figure 2: Modeling and Analysis supports:

Modeling and analysis supports the architecting in several ways during the project life cycle, see Figure 2. Early modeling and analysis efforts help to understand the problem and solution space. When the project gets more tangible the purpose of modeling shifts to exploration of specification and design alternatives. For some problems it is rewarding to optimize the solution by means of models.

When the realization gets up and running, then model and realization can be compared for verification purposes.

The insight that the goal of modeling changes during the project life cycle implicates that the type of model depends on project phase. We should realize that every model that we create has a goal. These goals evolve and hence models evolve. The model itself will not achieve the goal. We have to actively pursue the goal, for instance by applying techniques, to reach this goal.

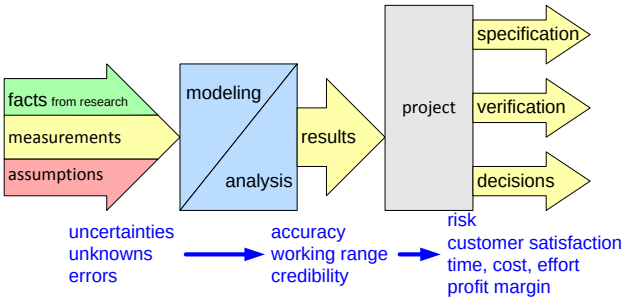

Figure 3: Purpose of Modeling

The purpose of modeling is to support the architecting effort. Figure 3 makes this purpose more explicit: the purpose of modeling is to support the project to get the right specification, design and to take the right decisions to achieve the project goals. *Right* specification and design is assessed in terms of customer satisfaction, risk level, meeting project constraints (cost, effort, time), and business viability (profit margin). In order to get to this point we need information, modeling results, with sufficient *accuracy*, *working range*, and *credibility*. These modeling results are based on the inputs to modeling:

facts from investigations, such as searching supplier documentation, customer or stakeholder interviews, market research et cetera.

measurements of components, previous systems and the context

assumptions whenever facts or measurements are missing or too expensive.

All these inputs have their uncertainties, may contain unknowns or may even be erroneous.

2 Overview of Modeling and Analysis Approach

The approach uses a simple model of the system and its context as shown in Figure 4. The system is modeled as black box, often called *system requirements*. Both functional or behavioral models can be used. However, we will focus mostly

on the so-called *non-functional requirements* in the black box view. The internals of the system are also modeled: the design, the realization, and technology choices and consequences.

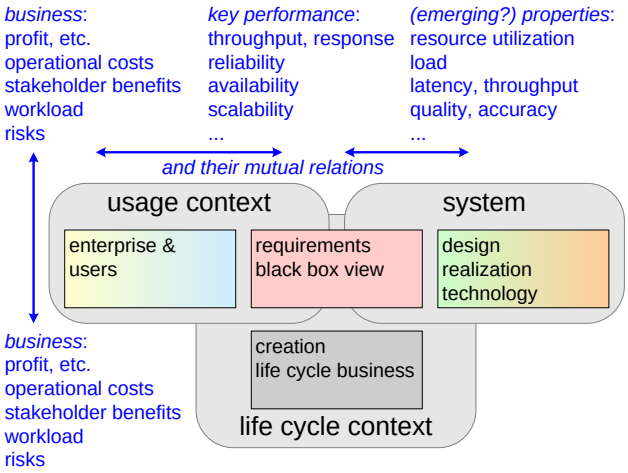

Figure 4: What to Model?

The purpose of modeling is to support the project in its architecting effort. The project purpose is always to realize a system in its context. A good system is a system that fits in its context and that is appropriate for its purpose. Figure 4 shows that we will model the *usage* context and the *life cycle* context. The *usage* context is often an enterprise with business processes and human users. The life cycle context starts with the creation or project life cycle, but it continues for the entire operational life of the system. Often a service provider is the stakeholder taking care of the system life cycle, from infrastructure to maintenance services and possibly even support for higher level application services.

Many models can be made for the system and its context, see Figure 4 for some examples. However, to achieve the modeling goal we are often interested in the mutual relations between black box view and design, system and context, et cetera. We stress again, modeling is a means to support the process.

The structure of the course and the supporting book follows the six modules shown in Figure 5.

overall approach providing an introduction and an overview of the overall approach to modeling and analysis.

input facts, data, uncertainties where and how to get quantified input data? We discuss measurements and the basis for dealing with uncertainties and errors. We also provide figures of merit for computer technology.

day 1	1. overall approach intro, overall approach, exercise overall approach
	2. input facts, data, uncertainties quantification, measurements, modeling, validation, technology background, lifecycle and business input sources
day 2	3. system modeling purpose, approaches, patterns, modularity, parametrization, means, exploration, visualization, micro-benchmarking, characterization, performance as example
	4. application, life-cycle modeling reiteration of modeling approach (see module 3), applied on customer application and business, and life cycle
day 3	5. integration and reasoning relating key driver models to design models, model based threads of reasoning, FMEA-like approach, modeling in project life-cycle
	6. analysis, using models sensitivity, robustness, worst case, working range, scalability, exceptions, changes

Figure 5: Program of Modeling and Analysis Course

system modeling via a number of examples we show how the system and design aspects of the system can be modeled. The main focus here is on performance, because performance is the most clear example of the value of modeling and a good illustration of the approach of modeling.

application, life-cycle modeling reiteration of modeling approach (see module 3), applied on customer application and business, and life cycle.

integration and reasoning an approach is provided to use multiple small models to take project decisions. A model based thread of reasoning relates customer key drivers to design decisions. We also discuss the role of modeling during the project life-cycle.

analysis, using models the purpose of analysis is to get answers on questions about sensitivity, robustness, scalability, in different circumstances such as typical case, worst case exceptions, et cetera. The impact of changes can be studied. The working range, credibility and accuracy are also discussed.

Figure 6 shows a visual overview of the modeling and analysis approach. At the top Figure 3 is shown. The program follows this diagram more or less from left to right: inputs, modeling of system, modeling of contexts, integration to support decisions and (back to) analysis. In the middle of the figure the map with it's stakeholders and concerns is shown. At the bottom the related models and the highlighted thread of reasoning is visualized.

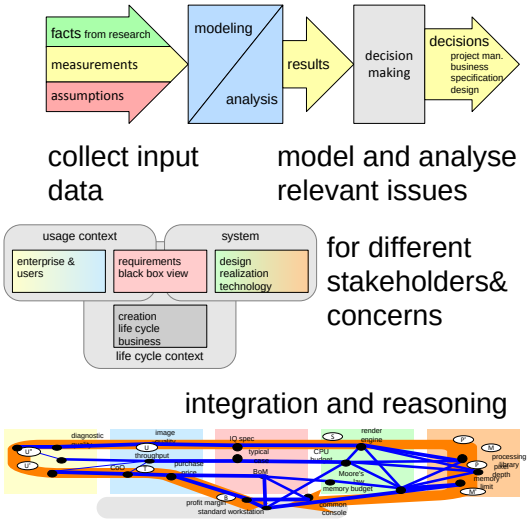

Figure 6: Overview of Approach

An important aspect of the approach is the continuous short-cyclic iteration. Figure 7 shows that the map is traversed many times, where both top-down thinking and bottom-up fact finding are continuously alternated. Top-down provides context understanding, intentions and objectives. Bottom-up provides know-how, constraints and opportunities.

3 Acknowledgements

Dinesh Verma initiated the development of a Modeling and Analysis course. Russ Taylor kept asking for structure and why, and provided feedback.

References

[1] Gerrit Muller. The system architecture homepage. `http://www.gaudisite.nl/index.html`, 1999.

History

Version: 1.0, date: 7 February, 2007 changed by: Gerrit Muller

- added text for all diagrams

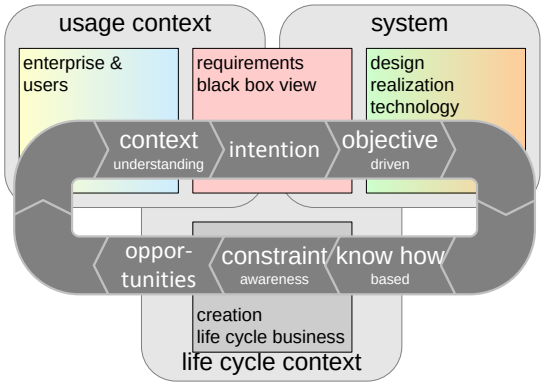

Figure 7: Iteration over viewpoints

Version: 0.5, date: 6 February, 2007 changed by: Gerrit Muller
- created body for article version

Version: 0.4, date: 11 January, 2007 changed by: Gerrit Muller
- removed MOSAD material, MOSAD or 525 is prerequisite know how
- Module 5 now focuses on integrated use of multiple models and reasoning. Also the *when*-question in the project life-cycle is added.

Version: 0.3, date: 4 January, 2007 changed by: Gerrit Muller
- Moved some material to background presentation
- removed CAFCR model
- made new overview slide
- reduced course to 3 days
- added purpose slide

Version: 0.2, date: 8 December, 2006 changed by: Gerrit Muller
- added What Why diagram

Version: 0.1, date: 6 November, 2006 changed by: Gerrit Muller
- changed status in preliminary draft
- added summary and reflection
- extended text on most slides
- small improvements

Version: 0, date: 1 November, 2006 changed by: Gerrit Muller
- Created, no changelog yet