

IBM Podcast

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MATHENY: Welcome to this IBM podcast, Developing Enduring Business Value Through Advanced Systems Engineering with Trade Studies. I'm Angelique Matheny with IBM. The ability to assess alternative solutions early in the production of a system or product is critical to delivering enduring business value.

Today, Dr. Graham Bleakley, principal consultant for systems engineering and architectural frameworks with IBM Rational joins us to discuss the benefits of a cross disciplines trade studies approach to systems engineering. Graham, welcome to the podcast. Thanks for joining us.

BLEAKLEY: Oh, no problem. Thanks very much, Angelique, for inviting me on.

MATHENY: Okay. So before we get into the details of the approach, could you explain a little about why creating trade studies is important to the product development lifecycle, and why you recommend a model-driven approach rather than traditional approaches.

BLEAKLEY: Yes. Well, trade studies themselves are about

trying to understand exactly what you want to achieve by your design or your development and then trying to work out solutions to actually realize it. By taking a trade study approach in a rational and structured manner, it really forces you to try and look at different solutions other than the ones that you've traditionally used within an organization: things like technology changes that may occur or things that you may not be aware of become less cost effective or more cost effective as the case may be. These can then be evaluated in a rational manner and brought into the solutions and compared against the existing solution.

Also, when we look at things in a traditional approach for analyzing trade studies this is very document driven. And documents tend to be all the over the place, people tend to lose them, even on computers. But with the model-based approach, you've got a single point of the [truth]. You have model which explains the relationships between different parts of, different ways of realizing different parts of the models. And it also, once you start to build up these models, it enables you to use libraries. And this enables you to reuse existing IP that you actually have in your existing organization.

And when you combine this with something like Rational Method Composer, which is a process management tool, it enables you to control how people are doing their work and

helping them understand and work through various issues in a very structured way and giving them guidance. So there are a number of benefits that you can get by taking the model-based approach.

MATHENY: Okay. Right. I can see why trade studies are so important and why using modeling makes sense. So can this approach be used for a variety of different types of product designs, or is it specific to an industry?

BLEAKLEY: It can be used across pretty much any domain where there's a choice or a set of choices that need to be made. It's especially useful for determine how to achieve things where you have conflicting requirements, and for instance, there is nearly always a conflict between cost and performance.

And it forces our issues such as which of these, what we call them assessment criteria, is more important to the users or to the developers of the system because we have to bear in mind that there are more stakeholders in the development process than just the end user. So, there are a lot of internal stakeholders which go to build this up.

It really is, it can be applied across any domain, anywhere where there's choices that need to be made to achieve something. So, it goes into the business domain, it goes

into product design. It can really be used for anything.

MATHENY: Okay. That does sound very flexible. Can you briefly explain the steps involved in your approach to developing trade studies?

BLEAKLEY: Yes, sure. This is the way that we do it basically in product development and product design. So, initially what we look is we look at what's being investigated and we break it down functionally. We look at what we need to do, not the how. And we develop a set of what we call system functions, anyone that systems engineer will understand. It's that concept of functional decomposition.

We then go through and we start to define some assessment criteria. The idea behind the assessment criteria is how well each function should be performed. Okay? In terms of system engineering, these tend to be the non-functional requirements, performance requirements that we would call them: how fast it should be, how fast it should accelerate, how much it should cost, how much a component should cost, how flexible.

These are our assessment criteria. Based upon these assessment criteria, we then need to work out how important they are. And there is technique such as the [pair wide]

multi-variable analysis, which allows to go from the very subjective idea which is more important, to one to having a very objective view of how these were created.

Once we've done this, we can start to define solutions. And we would define a set of solutions for a function, typically three or more, because we need to have some variance in it.

Once we have these solutions, we can start to build what we call a utility curve. The idea about the utility curve is to look at the variant across the range of the assessment criteria.

So if we have something which we expect to cost \$15,000 or 15,000 pounds, we can say, okay, we would expect it, we'll give it a range of, say, plus or minus \$5,000 or pounds. And if it costs, in this instance, say, \$20,000, we would score it very low, i.e., a zero, and you could score 10,000, they would score it very high, i.e., 10. And using this method for each of the different weights we could start to normalize for that number.

The next stage is to assign what we call NRE to the candidate solution. And by this, it means we look up our solution, say, how well has it achieved this successful criteria, i.e., this piece of equipment cost \$12,000, therefore it will score an eight; this piece of equipment cost \$17,000, therefore it will score a three, i.e. it has

the lowest score.

And we do this for each assessment criteria and for each of the solutions. And this is actually where a lot of the work comes into understanding the problem. Okay? A lot of the information can be gained from things like technical manuals which needn't come from experience. And it can come from other knowledge.

It does tend to push you to really understand the problems behind a particular solution. So as well as getting at what we get at, the rational understanding of why for a certain number they say this is their solution at the end of it, we'll also come out with a very good understanding of why these numbers make sense.

Once we've assigned these NREs to the candidate solutions for each of the assessment criteria, there is a mathematical formula, it's fairly simple, called the weighted objective table, which we can create automatically from the [INAUDIBLE] modeling probe, and it goes into Excel and it calculates the best solution for us.

And it's a case of multiplying each of the NREs by the [weight] for each of these technical criteria and then added them up. And the solution with the highest score should then be the best solution.

Also, because our understanding of the problem may change, we can start to change the weights in the model and we can start to affect how the models see things. And it becomes a good way of understanding the whole problem and solution space, the particular design as it were, a particular product.

MATHENY: Being a systems engineering approach, talk a little bit about why this approach can be useful to understand one's return on investment.

BLEAKLEY: Okay. One of the key aspects of almost any design project that you're going to be involved with is cost, and it's nearly always one of the most important assessment criteria which people pick.

So by looking at the cost between the different solutions, you're automatically making some judgment on what the return on investment is. Invariably you're looking to something that can be something cheaper than something else, even though the quality may be slightly different. So that's one way that you're bringing into the return on investment argument.

The other way is I've applied this problem also to manufacturing problems so instead of taking the product

design solution we can start to look at the manufacturing of the product and we can say, okay, which is the best approach given these sets of costs and given what our objectives are?

And by applying this approach to the manufacturing process to understand which manufacturing process or which types of manufacturing policy that you're going to carry out, it gives you a good understanding on the return on investment, and it helps ensure that you're getting the right return or picking the right method to realize the right return on investment you are actually trying to make into the product.

MATHENY: Graham, in our last question today, what do you think the learning curve is for this approach? Would it be a big change for someone that's already familiar with trade studies but isn't using a model approach?

BLEAKLEY: The basic concept in the trade studies are the same as what's been used in traditional systems engineering. The big thing is about trying to make it model based. And this is where a lot of the value is held. And it's very easy to do. We do our modeling using a tool called Rhapsody, Rational Rhapsody, and it uses standard System L systems engineering modeling notation. And this is where we build our models and where we evaluate them.

And it would be very simple to pick this up. I mean, System

L in its own way is very similar to the back of the napkin approach to the most systems engineers that designers are familiar with. So it's just contained in a model, and the elements that you are producing are model elements.

So if you change one, it's changed throughout the model. And this gives you great benefit because if you change it drawing on one napkin, you're not going to get the same effect on the other napkin. But yes, it should be very easy for anyone in the trade studies to pick up.

MATHENY: Graham, thanks so much for sharing your time today to discuss this podcast, Developing Enduring Business Value Through Advanced Systems Engineering with Trade Studies. We really appreciate it.

BLEAKLEY: You're very welcome.

MATHENY: That was Rational's Dr. Graham Bleakley, Principal Consultant Systems Engineering and Architectural Frameworks. If you are interested in more podcasts like this one, check out the Rational Talks to You Podcast Page at www.ibm.com/rational/podcasts.

To help you get started, we'll include the link to this white paper entitled, Smarter Systems Development, A Systems Engineering Trade Study to Support Green Initiatives With Model-Driven Development. So, check it out today. This has

been an IBM podcast. I'm Angelique Matheny. Thanks for listening. Keep tuning in as Rational Talks to You.

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