**Concept of Model Based Enterprise**

**Definition of Model Based Enterprise**

A model based enterprise is the environment in which MBD is the primary product definition or design authority

A model based enterprise (MBE) is an integrated and collaborative environment founded on a Model Based Definition that is shared across the enterprise, enabling rapid seamless and affordable deployment of products from concept to disposal.

A product or systems life cycle goes through the following stages:

* Concept
* Definition
* Materials and Manufacturing
* Use and Service
* End of Life

The model goes through this entire life cycle

Requirements = statements of need

**Model Based Enterprise Self Assessment**

**Tools:**

The NIST assessment tool divides model-based enterprise readiness into six levels. Each level has specific expectations and gives you an idea of the changes that need to be made in order to go from one level to the next. The NIST scale starts at level zero which is basically traditional design practices where a company uses drawnings and manual processes to convey information. The last level. Level size, there is full connectivity throughout the enterprise.

Another way to look at these different levels is that level zero is drawing-centric resulting in a completely disconnected manufacturing enterprise. As we step up in levels, we move into model centric where additional information is embedded into the process.

Concretely, at level two, we are starting to look at situations where the drawing and model are managed together. At level three, we begin to pivot to a point where the model is the focus and drawings are supplemental. At this level we have a model-based definition perspective of MBD. Level three approaches have models containing some product and manufacturing information or PMI with some drawings to provide supplemental information not contained within the model. For level three, we are still dealing with a disconnected enterprise. But are starting to integrate some activities with a single source of information. Level four increases the degree to which the model drives the process and drawings are no longer used. So the model contains a complete product definition in PMI. Levels five and six are the highest levels of the scale where the model-based definition transitions to an integrated enterprise. On level five, we begin to have an integrated manufacturing perspective as well as an integrated internal enterprise. So working within your company or your organization, you're using the model to support your decision making even to the point where you're working with it in some nontraditional activities. Level six is the most aspirational level. This is where manufacturing is tightly integrated based on the model including the extended enterprise. The extended enterprise refers to the entire supply chain using the model to communicate with the model driving all associated activities. This is true digital manufacturing and design. One of the classic questions about MBSE particularly when an organization is looking to adapt it is, what's the ROI? What's the return on investment. It's a fair question but it's a very difficult question to answer because the ROI on systems engineering itself is hard to answer. The ROI on systems engineering is, what is the cost of an error that you never encountered? If you do systems engineering well, it really means that you will not encounter issues. And so, therefore, proved to me that it has any value. With that as context? It's hard to point to a specific system and a specific application of model-based systems engineering and say there's the value. But I'll pull back and talk about a product line because most of us live in product line organizations. One of the organizations that we deal with this a classic aerospace and defense firm and they've done a number of drones, UAVs. They did fixed wing. They did rotary. They did subsea. They did sensing platforms. And they did delivery platforms. And they were an early adaptor of model-based systems engineering techniques. They applied model-based systems engineering to each of these individual systems. They found value but it was hard to quantify. Over time, what they realized looking at these high fidelity representations is there's a common way that we build drones in this organization regardless of what the exact purpose and the exact technology is. So they abstracted out what's called a reference architecture that common way, those common requirements that they respond to, the common physical architecture, the common functions. And once they had that reference architecture in a high fidelity representation, they gained four primary benefits. First off, they had a common language within their organization. They eliminated what's known as the plague of vague. They eliminated miscommunication because when they used a word it had a defined meaning and that immediately brought quality implications to their future systems. Second, they radically accelerated the time to market of a new problem because when they got a new request they didn't start from a blank sheet of paper. They had a reference architecture which they could build upon and customize. Third, they found more commonality in their product line or in their family of systems. They used common technologies and only deviated when there was a reason. And the fourth is probably the most important. They had a built-in learning system. When they completed a new system, they compared it back against the reference architecture to say what should we build back into the reference architecture? And what is really one-off for this system that we just built? So while it's hard to reflect on any one of those and say the ROI for delivering system X is fill in the blank, they can look at the product line or the family of systems and realize those four key benefits and therefore gain tremendous value simply by representing their knowledge better. And that's what MBSE is all about. There are a few MBE capability tools out there that you can use for assessment. One that I want to talk about first, is the NIST capability tool. The initial version is basically a large text chart that can be downloaded as a PDF. I printed off a copy here and have a larger version behind me. This version gives you different categories each with pretty good descriptions of the requirements for each level of MBE capability. Using the tool, you can understand the purpose of requirements for each level. And then basically, you can go through, look at it, and if you satisfy the requirements for a level, good. If not, you might use that to evaluate some gaps between where you are and where you want to be. A group called Action Engineering has taken a different approach to MBE assessment. Rather than using six levels, Action Engineering uses three levels. Basically, traditional, current, and state of the art. Doing so gives people a much simpler way of assessing where they are especially relative to their competitors and relative to the state of current technology. The scale is not useful in setting a roadmap that is forward-looking for multiple years. But it's easy as a quick check to see how far ahead or behind you are from your goal. In the resources section, we've included a link to a document that gives you an idea of how Action Engineering performs model-based engineering assessment. At the end of the module you'll be asked to perform your own model-based enterprise assessment. To do so, the remainder of this module is going to focus on specific areas of manufacturing and design where MBE can play a role. Some of this is admittedly vision-casting and forward-looking. For some of the categories, commercial offerings have not yet caught up to all of the concepts presented here. However, it's a very dynamic situation with implementation capabilities maturing very quickly. The assessment tool that will frame the discussion of model-based enterprise for the remainder of the module, is the second generation of the NIST MBE capability assessment. Also available in the resources section, this is an Excel spreadsheet with many capabilities. To get started, I would still use it just looking at the text and using the requirements of each level to determine MBE readiness. For those who are more quantitative and want to score, the Excel spreadsheet allows you to do that and can generate a radar plot to show how strong you are in different areas. From a strategic planning perspective, this can help you to understand where you might want to invest to bring yourself or your organization up one or more levels on the MBE scale. The updated version of the NIST tool, the Excel version, is available via github. So NIST can keep the latest version always easily available.