Product Maturity Metrics (PMMs)
— a concise and effective way to assess and communicate program risks —

Dr. Thomas Fiorino
Thomas.Fiorino@APTCorp-US.com
703-237-9545

4 June 2012
Why Product Maturity Metrics™ (PMMs)?

- Over the last ten years various GAO audits and reports, Nunn-McCurdy breaches (high cost, delayed programs) and test/field failures all point to a DOD acquisition process that needs improvement. Highlights of the GAO findings are:
  - There is little incentive for DOD program managers to capture knowledge early in the development process
  - In 2008 the cumulative cost growth of 96 major defense acquisition programs was $296 billion
  - The total acquisition costs for these programs increased 25% from first estimates
  - The average delay in delivery to the war-fighter was 22 months
  - DOD needs to do a better job ensuring acquisitions begin with realistic plans and baselines prior to the start of development

- The April 2009 GAO report further delineates a clear set of prerequisites that must be met by each program’s acquisition strategy before a measurement of the program’s health will be of real value
  - Establishing an evolutionary, knowledge-based business case for each acquisition
  - Separating technology development from product development
  - Limiting time and requirements for product development to manageable levels
  - Employing systems engineering early on in the process to arrive at realistic cost and schedule estimates
PMM Background

• In 2002 Engineering Manufacturing Readiness Levels (EMRLs) were developed for the Missile Defense Agency as a standardized methodology to assess risk during product development and production utilizing:
  ▫ DoD and Industry Best Practices
  ▫ Willoughby Templates
  ▫ GAO recommendations

• EMRLs have proven to be effective as a streamlined, objective measure of product maturity and risk identification at key milestones in programs such as:
  ▫ Aegis BMD and THAAD
  ▫ H1 Helicopter, ARH-70A Helicopter, P-8A Aircraft, JSF, and F135 Engine

• EMRLs incorporate and streamline both Manufacturing Readiness Levels (MRLs) and Technology Readiness Levels (TRLs), in addition to incorporating the broader programmatic risks
  ▫ MRLs focus on in depth evaluation of manufacturing
  ▫ TRLs focus on in depth evaluation of technology

• PMM criteria and metrics, refined and enhanced to improve their utility, were developed to provide differentiation from MRLs and TRLs while maintaining the EMRL concept of an easy-to-use tool to assess product maturity during development and production
PMM Benefits

• PMMs provide the product manager (PM), integrated product teams (IPTs), and independent reviewers with an easy to use, resource friendly means to:
  ▫ Assure systems engineering is employed early on in the development process
  ▫ Assure realistic plans and baselines are in place at the start of development
  ▫ Measure technology and design maturity before entering product development
  ▫ Limit time and requirements for product development to manageable levels
  ▫ Capture knowledge early in the development process and reduce the risks of cost, schedule and performance problems

• PMMs provide the PM and others the ability to quickly assess product development high risks as part of scheduled product status reviews in addition to major milestones or gate reviews

• PMMs provide PMs with 20 criteria and associated metrics, enabling them to concisely and effectively assess product development status and risks at the product level, as well as lower levels in the supply chain
PMM Description

Product Maturity Metrics™ are a means of concisely and effectively assessing and communicating the degree to which a product is designed to be producible, reliable, sustainable, and affordable.

PMMs:

- Measure product maturity during all phases of design, development, and production
- Establish a level of risk at each product development milestone
- Capture knowledge required to successfully transition with minimal risk
- Measure time certain development and delivery of a product during design, development, and production
- Are composed of five gates matched to an established product development milestone with twenty consistent criteria and corresponding metrics

PMMs provide concise and easy to use measures of product maturity and risk
PMM Best Practices

- PMM 1 – ASR complete before Milestone A decision
- PMM 2 – PDR complete before Milestone B decision
- PMM 3 – CDR complete and design stability demonstrated

Note: An analysis of current ASR, PDR, and CDR guidance and checklists shows a lack of consistency and completeness from one review to the next across the Acquisition Lifecycle Framework.
Product Maturity Gates

DoD 5000.02

Materiel Solution Analysis

Technology Development

Engineering and Manufacturing Development

Production and Deployment

Ops and Support

PMMs
(Product Maturity)

PMM 1
Entrance to Technology Development

PMM 2
Entrance to Product Development

PMM 3
Entrance to Product Demonstration

PMM 4
Entrance to Low Rate Initial Production

PMM 5
Entrance to Full Rate Production

1 to 2 years

2 to 5 years

1 to 3 years

Time Certain Development and Delivery
Phased Maturity

• To minimize product development risks, products lower in the supply chain should be more mature in development (at a higher PMM gate) than the next higher level product
• As example, an infrared heat-seeking missile:
  ▫ Missile has met the entrance criteria for the Product Development Phase (Milestone B/PDR)
  ▫ Sensor Assembly has met the entrance criteria for product demonstration (CDR)
  ▫ Focal Plane Array should be at or near Low Rate Initial Production (LRIP)
Performing an Assessment

• To implement a PMM assessment for a product, the PM must first determine where the product, subsystems, and components are in the development cycle based on the scheduled reviews and milestones
  ▪ This will establish the maturity gate against which the product and lower level products in the supply chain should be assessed
  ▪ PMM assessments should be performed from Materiel Solution Analysis until the product is transitioned from production

• To transition from one phase of development to the next with minimal risk, all of the entrance criteria for a particular gate or milestone should be met
WBS Assessment Level

- Product Manager determines at what level in the WBS structure to initiate assessments
  - Assessments are conducted using either a top-down or a bottom-up approach
  - Product should be decomposed at least one or two levels down to begin an assessment at the product level
  - Effective initial assessments can be made with one or two levels of detail from the subsystem level and/or the component level, and then at the product level
PMM Templates

The assessment template consists of two worksheets:

- **The detail worksheet**
  - Lists several sub-factors or guidance for each criterion
  - Has area for capturing evidence and notes
  - Automatically updates the summary worksheet

- **The summary worksheet**
  - Shows the 20 entrance criteria
  - Shows the one page score summary
  - Is useful for reporting purposes

The assessment is conducted using the detail sheets.
PMM Detail Sheets

- Rate the risk of 20 criteria and metrics
- Sub-factors for guidance only
- Capture evidence and notes
Risk Rating Criteria Metrics by Color

The PMM assessment uses a Green, Yellow, and Red color scheme to rate the maturity and risk for each of the twenty entrance criteria listed. Each color is defined as follows:

**Green** – Product meets the entrance criterion or requirement for the gate assessed and is within cost and schedule

**Yellow** – Product does not meet the entrance criterion or requirement for the gate assessed; however, the entrance criterion or requirement will be met without impact to cost or schedule

**Red** – Product does not satisfy the entrance criterion or requirement for the gate assessed and meeting the criterion will impact cost, schedule, or both

**N/A** – “Not applicable” should be avoided; use only if the criterion does not apply at the gate of product being assessed
PMM Assessment – Block Report

- A WBS overview display can be constructed based on PMM assessments performed.
- Display shows high risks at all WBS levels assessed.

```
<table>
<thead>
<tr>
<th>Criteria Number</th>
<th>PMM 1</th>
<th>PMM 2</th>
<th>PMM 3</th>
<th>PMM 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>2</td>
<td>G</td>
<td>G</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>3</td>
<td>G</td>
<td>Y</td>
<td>G</td>
<td>Y</td>
</tr>
<tr>
<td>4</td>
<td>R</td>
<td>R</td>
<td>G</td>
<td>G</td>
</tr>
<tr>
<td>5</td>
<td>G</td>
<td>G</td>
<td>G</td>
<td>G</td>
</tr>
<tr>
<td>6</td>
<td>R</td>
<td>G</td>
<td>G</td>
<td>G</td>
</tr>
<tr>
<td>7</td>
<td>Y</td>
<td>G</td>
<td>G</td>
<td>G</td>
</tr>
<tr>
<td>8</td>
<td>R</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>9</td>
<td>Y</td>
<td>G</td>
<td>G</td>
<td>G</td>
</tr>
<tr>
<td>10</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>11</td>
<td>G</td>
<td>G</td>
<td>G</td>
<td>G</td>
</tr>
<tr>
<td>12</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>13</td>
<td>G</td>
<td>G</td>
<td>G</td>
<td>G</td>
</tr>
<tr>
<td>14</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>15</td>
<td>G</td>
<td>G</td>
<td>G</td>
<td>G</td>
</tr>
<tr>
<td>16</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>17</td>
<td>G</td>
<td>G</td>
<td>G</td>
<td>G</td>
</tr>
<tr>
<td>18</td>
<td>Y</td>
<td>G</td>
<td>G</td>
<td>G</td>
</tr>
<tr>
<td>19</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>20</td>
<td>G</td>
<td>G</td>
<td>G</td>
<td>G</td>
</tr>
</tbody>
</table>
```
PMM Assessment – Flag Report

Display shows high risks at all WBS levels assessed
Summary

• PMMs provide the product manager, product support teams, and independent reviewers with an easy to use, resource friendly means to:
  ▫ Assure systems engineering is employed early on in the development process
  ▫ Assure realistic plans and baselines are in place at the start of development
  ▫ Measure technology and design maturity before entering product development
  ▫ Limit time and requirements for product development to manageable levels

• PMMs enable the product manager to capture knowledge early in the development process and reduce the risks of cost, schedule and performance problems

• PMMs provide the product manager and others the ability to concisely and effectively assess product development risks as part of scheduled product status reviews, in addition to major milestones or gate reviews

• PMMs provide product managers with the criteria and metrics to assess product development status and risks at the product level, as well as lower WBS levels (lower levels in the supply chain)