White Paper (DRAFT)

Effective use of MRLs in an S&T Environment

Adapting MRL Criteria in an S&T Program

Adapting MRLs effectively in the S&T environment is probably the most challenging of all the various situations. MRLs were designed to measure the manufacturing readiness of a product and/or process as it matures towards production. However, in early S&T there is often very little linkage between the research being performed and a product or specific production program. Therefore, some of the criteria might have to be adapted to achieve the goals of an S&T environment (e.g. to obtain fundamental knowledge). The primary objective for using MRLs is to improve the decision makers' ability to understand and mitigate manufacturing risk in development efforts transitioning from S&T to acquisition. Our ability to transition technology smoothly and efficiently from concept, into the lab, onto the factory floor, and into the field is essential to be cost effective and to reduce cycle times in an acquisition program.

Projects funded by the S&T community are not usually funded beyond the S&T effort. This puts the S&T community in a dilemma when their goal is to meet the MRL 5 or 6 maturity at the time of transition. The MRL criteria contain acquisition language that may not be relevant to S&T funded efforts as the acquisition language refers to budget estimates, process capability, and target yields for pilot line, LRIP, and FRP and in some cases milestone C. Even meeting MRL 5 criteria for many S&T programs is difficult if the MRL criteria are not interpreted to address the specific S&T objectives. However, many MRL 5 - 6 criteria, such as those dealing with quality, design, materials, facilities and workforce, are very valuable in reducing manufacturing risk for technology transition. Therefore, it is recommended that all MRL criteria be assessed and interpreted to take advantage of valuable risk reduction benchmarks while not being penalized by benchmarks that do not apply. In some cases, the interpretation may be that the criteria containing acquisition language are not applicable to the S&T program being assessed as they pose no manufacturing risk to the S&T effort. When a criterion is assessed to be not applicable the reason should be well documented and provided to all transition customers.

Appropriate Application of MRLs in Science and Technology Programs

It has been raised during discussions with industry and government stakeholders that under certain circumstances, maturing a technology or manufacturing capability beyond an appropriate MRL prior to technology demonstration in a relevant environment (TRL 6) may have adverse or unintended results. There are three areas where decisions for appropriate level of manufacturing maturity must be considered: situations where competing technology solutions are being explored in order solve an operational capability or developmental gap; situations where a technology has not yet been demonstrated as useful; and situations where production decisions may impact the utility of previous manufacturing maturation efforts.

Technology Maturity: the Case of Competing Technological Solutions

Technology development by nature is a high risk business. Often times there are a number of paths to address an operational gap, each with its own unique technology solution. During the technology development phase of a product, the analysis of alternatives may lead to selection of one technology over other competing technologies. These technologies may be completely different with unique physical and material characteristics. For example, a passive solution for protection against a bullet strike through a hard protective shell that absorbs the force of a bullet versus an active protection solution such as a device that reaches up and deflects that bullet. Both have differing levels of technology challenge and until a certain level of technology maturity is reached (i.e., TRL 6 demonstration in a relevant environment) to determine whether that technology works, it is reasonable to mature manufacturing processes sufficient to affordably demonstrate that technology (e.g. MRL 4).

This decision has to be on a case-by-case basis. Certainly there are cases where it makes sense to mature the manufacturing processes as early as possible during technology development. An example is yield for infrared focal plane arrays. For this technology, a higher MRL level for producing these key components lead to affordable demonstration of a system capability (TRL 6) as well as more affordable solutions during system maturity (EMD) and full rate production. Likewise, there are cases where it is understood that a technology, although not yet demonstrated in a relevant environment (TRL 6) must begin to address affordability earlier in the development stage in order for that technology to be affordable enough to transition post-TRL 6. The bottom line is that the technology program manager must balance the appropriate use of investments to assure that manufacturing maturation is appropriate for that system and its stage of development.

Process before Product: Maturing Manufacturing Processes Higher than Appropriate for a Particular Technology or System

In this situation, demonstrating an MRL of a technology (e.g., MRL 7 or 8) may be inappropriate for that technology until it is sufficiently demonstrated in an operational environment. An example is a multi-layered material application system, where that manufacturing process is matured to produce high levels of this material for a particular system, resulting in low manufacturing cost and therefore low barrier to implementation. However, during operational test the material separates under high pressure and therefore fails technically. This is a very difficult situation to address, but is important for a technology program manager to understand the appropriate level of manufacturing maturity investment relative to demonstration of that technology in an appropriate environment. ICME (Integrated Computational Materials Engineering) approaches can help predict the impact of process on materials and resulting performance of a system in operational environments.

Risks Beyond MRL's- Manufacturing Maturity at an Appropriate Level Prior to Production Decision (pilot line versus production)

In this situation, a pilot line may be established to demonstrate a particular MRL level, perhaps to meet a contract requirement or demonstrate a manufacturing capability to establish a transition path with a program of record. Once a production decision is made, moving from a pilot line (which may currently produce enough product for LRIP) to another physical location may dramatically reduce the MRL level.

In some cases, past manufacturing maturation investments only apply to pilot line and do not ultimately transition to a full rate production environment. The key is for technology programs and acquisition programs to understand risks associated with production decisions through close interaction with the supply chain, and utilization of tools such as IBCA (Industrial Base Capability Assessments) which can identify programmatic and schedule risks beyond what is scoped within the 9 MRL threads.

In summary, MRL criteria has been developed with the objective of providing an effective and efficient process to transition a concept into production, and S&T does not necessarily have those same objectives. The real value of MRLs is a better understanding of and position to manage risk. The results of an MRL assessment allow managers the basis for implementing decisions on whether to accept the risk or reduce the risk.