**DRAFT**

Metrics

Disclaimer – Standardizing a set of metrics, prior to assessing any situation and understanding what you will do with the data, is extremely risky in effectively managing a program. By providing the inexperience workforce with a set of metrics it may eliminate any and all critical thinking and sound judgment required to effectively manage the program. The worst case situation would be tracking something perceived to be important (e.g. standardizing set of metrics), and doing a great on those metrics, while the program is experiencing significant cost, schedule, and performance problems and you not having a clue why that is the case.

However, even with the above disclaimer, I believe metrics can be extremely important in managing any effort. In my opinion the key is performing a thorough analysis of the situation and identifying the risk areas that need to be managed in you achieving your objectives. Therefore, you need to start with your objectives and for most programs it will breakdown to making your cost, schedule, and performance objectives. You need to assess your program parameters and identify the constraints that present you the most risk and then put metrics in place to monitor the situation, If there is no time or resources to perform such an assessment then you will have to rely on lessons learned to begin with in establishing your metrics, and maybe that is what you would consider a standard set of metrics. The key questions you should ask in selecting any set of metrics are;

* Why these metrics? Is this a critical area? How does it relate to your strategy and/or objectives?
* What am I going to do with the data?
* Who cares about these metrics and why?
* How do I get the data?
* Is the data reliable? – timely, accurate, etc
* Is the metric a lagging one (i.e. after the fact usually associated with a product) or leading one (before the problem impacts your objectives - usually associated with a process)?
* Am I measuring both processes and products that are the keys to success?
* Am I measuring at too low or high a level?
* Does the metrics reflect the real situation? Focusing in on the wrong area is a real potential problem.

The reason I like a program to perform a manufacturing readiness assessment is that you would be able to get the answers to the majority of these questions. The MRLs focus on the maturity of manufacturing process in a sequential manner, which if followed, will increase the probability of identifying the likely risk areas that will impact the program objectives from a manufacturing perspective. It will not solve world hunger nor as a matter of fact solve all the problems in acquisition, but, in my opinion, it’s the best tool available in the manufacturing area to identify the risk areas and then select the appropriate metrics to be used.

**KEY** Whatever metric you decide to use it is essential that you can relate it to you objective(s) and thereby understand why it is important, and if you are not achieving your targets (e.g. missing your dates, not achieving your goals, etc.) that you perform an **assessment of the impact and identify the root cause**. As a professional you need to be able to manage the problem which requires you to identify what is causing the problem, what needs to be done to solve the problem, and finally the impact the problem is having on their program.

**NOTE** There is so much synergy between impacts on performance, cost, and schedule it would be difficult to isolate any issue to just one of these objectives.

The fundamental job of any acquisition professional is to increase the probability of a program succeeding. There are just too many unknowns to ensure success but by focusing on critical risk areas and using metrics effectively to management you can have an enormous impact on increasing the probability of success.

Manufacturing Metrics

**NOTE** I used these metrics in EMD and early Production. Prior to those phase I believe you have to develop unique metrics focusing on risk reduction efforts, focusing on big picture items (e.g. industrial base, technology and manufacturing demonstration in relevant environments, new and unique process, new and unique materials, etc.)

Prior to performing an MRA or any other program assessment I would focus on the following metrics/areas to begin my efforts. Note I would look at the same metrics at the **Prime and expect the Prime to look at on major/critical subcontractors/suppliers**.

The list of thinks I looked at align with the categories found in the MRL Matrix. I would look at the following areas to see how they are impacting my cost, schedule, and performance objectives;

**First is Schedule – and the metric is missed milestones further it is critical that you get down to tier 3 and 4 levels – if you focus on the tier 1 and 2 (e.g. major milestones) efforts you will probably be too late to have any real positive impact or proper advance notice to key leaders.**

* First metric is answering this question – Is the schedule realistic? But you need to answer the second question immediately following that one and that is “Why is realistic?”
* This is one of the most important metrics a manufacturing professional must understand and it is essential that he/she understand the company’s MRP/EMS/etc. In the old days I used Line of Balance (LOB) but with today’s system you should be able to get significantly more insight. **The reason tracking your schedule is so important is that it will probably be you first quantitative indicator of cost and performance issues.** For you to do your job here you must understand the assumptions used in defining the schedule for following activities and be able to measure planned versus actual;
  + Funding releases to begin work
  + Design releases
  + P.O.s releases
  + Parts received
  + Start day for Fab/assembly/test/ etc
    - Hardware
    - Tooling
    - Test Equipment
  + Begin Qual testing, ending qual testing, etc. etc.
* It is important to understand the critical path to adequately assess the impact of missed milestones .In addition you need to understand what assumptions are being used to determine cycle times and quantities (e.g. scrap/rework rates, standard hours, realization factors, crew loads, number of shifts, etc.) and you should monitor those assumptions you consider risky . **Not making these assumptions are usually one of leading indicators of a program problem.** 
  + - This whole area is so fundamental it deserves a major focus on training and follow-up by all manufacturing organizations.

**Design** – One of the most important metric to understand and track since it drives manufacturing/material requirements (e.g. hardware, tooling, test equipment, P.O.s, etc.). Some of the key metrics here are;

* Drawing releases - compare actual versus schedule
  + If drawings are late probably will impact whole program
  + Quality of drawings will also have a major impact – discussed in quality metrics below
* Configuration Changes – **design stability** looked at actual change rate to what was in planning – always a major driver
  + Look at what is driving these design changes
    - Needed to build hardware (e.g. producibility issues)
    - Needed to make hardware work (e.g. performance issues)
    - Changing requirements (e.g. User Issues)
* Track qualification schedule for hardware
  + Look to ensure you understand the risky sections of qualification (e.g. vib, temp, etc.) and when they are scheduled and completed – note if these risky ones fall at the tail end of qualification you will have probably have more problems later in your program
* Good Process metric here to assess manufacturing involvement is ensuring manufacturing is a team member of the design process but as a minimum is reviewing the design for producibility and manufacturability issues.
  + Need to make sure it is not a rubber stamp process – O.I.s should spell out the process and you need to ensure manufacturing personal are assessing process capability versus design requirements and identify issues. Look for feedback to design identifying concerns– note if this is not happening it should be a concern. The following should be provided to the design team, if not probably not working;
    - Identification of manufacturing concerns
    - Providing impacts of special/new materials, processes, tolerances, rates, etc

**Parts/material** in from outside sources – including IDWAs

* P.O. releases – compare to schedule to actual
  + When not making schedule would look at impact
* Good Process Metric - Ensure Major/Critical subcontractors are identified
  + Look for list of Major/Critical Subcontractors
  + Look at how Prime Managed these subcontractors
    - Obtain access to these reports
    - Tracked metrics used to manage these subcontractors
  + Develop a color code for subcontractors on key areas – cost, schedule, tooling, qualification, etc., etc.
    - Red – High probability (my call – usually greater than 80%) it is a serious problem to key program objectives
    - Yellow – Medium – 40 -80%
    - Green – Low and issues are mainly internal at subcontractor with acceptable corrective actions in plans
* Look at parts coming in – compare to schedule to actual
* Look at quality results
  + Note it is important to look at each part and not get focusing on overall numbers

**Manufacturing Infrastructure metrics**; ***Note the importance of these metrics are usually unique to program situation and requirements;***

* **Manpower** – Track by skill codes
  + Requirements versus actuals
  + Attrition and hiring rates
    - Note if I ever increase or decrease manpower by over 10% in any one month I would be concerned and look for other problems (e.g. scrap/rework increasing, missing schedule milestones, cycle times increasing, etc.)
  + Overtime rates – if over 10% for more than 3 months you need to understand why.
    - This needs to be tracked at the lowest work cell possible. If tracked at too high a level serious problems could be hidden.
    - Root cause analysis is valuable in this area.
* **Tooling and Test Equipment** 
  + Design releases
  + Track Fab, verification and validation, of the ST/STE versus schedule
* **Facilities**
  + Track any new or modifications to the following
    - Plant Space
    - Machines
    - Environmental and special handling equipment
  + Note if you are going to build hardware in a different place then where you are currently building it you should always consider it an item of interest and needs to be monitored.
* **Work Instructions**
  + Releases versus requirements
  + This is a good area to monitor to ensure they are not only being released on time but that they are adequate (e.g. understandable, referencing the right configurations and processes, identifying tooling/test equipment needed, etc.)
* **Manufacturing Capabilities that need to be track** 
  + New Processes
  + New Design requirement not seen on factory floor before – tolerances, size, shapes, etc.
  + Rates greater than normal. Etc
    - The thinks you track are output versus plan
      * Cycle time
      * Re-work
      * Yield
      * Hours
      * Schedule
* **Manufacturing Management**
  + This is good process metric to use in assessing risk – if these activities are not done there exist a higher level of risk of something not getting done
    - Manufacturing Plan Developed
      * Mfg Plan integrates all manufacturing infrastructure activities

**Cost is another great metric to track, and as stated before there is a significant amount of overlap between cost, schedule, and performance issues. It is my experience that when we in manufacturing talk cost it translates directly to hours, therefore the metrics I would recommend in this area would be associated with hours.**

* **Manufacturing Build Hours**
  + Hours per Unit – would recommend going down to at least major sub-assemblies but extremely important to understand how estimates are established and assessed.
    - Estimated versus Actuals is an excellent metric
      * Important to - Understand how estimates where establish to understand the risk in achieving them
        + Used = Actuals, Similar to Hardware, Some type of standard. etc.
      * **Good Process Metric -** Important to understand how company assesses the differences between actuals versus estimated – (i.e. what is their variance analysis looking at and what is it telling you)
      * Important to understand how the hours relate to overall cost objectives
        + Need to understand rates (e.g. $120.00/ Hr.)
        + Need to understand what is in the manufacturing Hrs you are looking at and how it is allocated and tracked – (e.g. labor to build hardware, support labor, etc.)
      * Important to know the learning curve estimates are based on and you need to track the actual L/C
* **EVMS Data** – If you have EVMS data available you need to understand how manufacturing efforts relate to the efforts that are being tracked and reported.
  + EVMS data tends to lag other key metrics within the manufacturing domain but it is important to track and understand the manufacturing drivers in this area because it is a big picture metric that we be tracked by management plus it might give you some insight into a systemic manufacturing issue.

**Performance in the manufacturing area, in my experience, is associated with quality metrics. Versus design which is associated with qualification testing. The quality metrics are good indicators of the health of manufacturing. Note – however, the root cause to quality problems are not all solved by addressing just manufacturing but could and probably will require an assessment of the design requirements.**

* **Quality Metrics**
  + **First Pass Yield** – Tracking the acceptance rate of any process, whether it be a fab or test operation
    - Important to compare actual versus plan in this area because it can be a leading indicator of a serious problem
    - Note – if first pass yield is not making target of is below 80% you need to assess impact and risk
  + **Scrap, Rework, and Repair** – Tracking the actual SRR factor versus what was planned provides valuable insight into potential problems
    - Important that you track this at lowest work cell possible since problems can be hidden if summarize at too high a level
    - This can be a major cost and schedule driver if it exceeds original projections
      * It is an area that needs to be track and when exceeds projections a root cause analysis should be performed along with an impact assessment
    - SRR is usually measured in percent of labor hours
  + **Material Review Board Actions** – Tracking the number of actions going to the board versus projections is a good indicator if your original assumptions are correct.
    - Too many actions and or major actions can indicate a serious problem that could impact cost, schedule, and performance objectives
    - A high percentage of Use-As-Is decision would indicate further investigation is needed in the MRB process
  + **Design maturity**
    - Class 1 and 2 change rates versus projections
    - Liaison Engineering call rates – look at trend
    - Manufacturing stop work notices rates- should be very low
    - Root cause, from my experience, of most delays in Work Authorizations beginning on time are late drawings and design changes the next major one is part shortages
  + **Quality of the Bill of Material**
    - BOM matches the design releases – should be very high, if not you probably have a problem
    - BOM matches the work instructions– should be very high, if not you probably have a problem
  + **Out of Station Work**
    - Any out of station work indicates there is a problem and should be tracked and analysis.
  + **Waivers and Deviations (W/D)**
    - Any W/D is an indication of a problem and should be assessed.
    - Trend is very important here – if going up need to address immediately
  + **Quality Deficiency Reports (QDRs)**
    - Any QDR is an indication of a problem and should be assessed
    - Trend is very important here – if going up need to address immediately
  + **Service Reports (SRs)**
    - Any SR is an indication of a problem and should be assessed
    - Trend is very important here – if going up need to address immediately
  + **Good process metric –** contractor is controlling and improving the manufacturing processes – this is a good sign of a quality company
    - Performs process capability studies
      * Compares design requirements versus manufacturing capabilities
        + Highlights new manufacturing capability requirements
      * Contractor measures his process capabilities
        + Has active statistical process control program

Summary – the metrics identified will have significantly overlap in driving cost, schedule, and performance. It is strongly recommended that you never overlook the big picture in tracking any metric – (i.e. are you making your cost, schedule, and performance objectives and a good top level way to track that is EVMS – Earned Value Management System – or whatever the company uses that is similar). **Key – Before going to management always know the impact, root cause, and have a propose action plan needed to minimize the impact.** Bottom Line you must understand the big picture objectives.