Welcome the Logistics Officer Association Professional Development Module 2, Air Force Sustainment Center Production Science. This module was developed by the Tinker Air Force Base Crossroads Chapter. The purpose of this module is to give members a brief understanding of the underlying theories that the AFSC uses to provide weapon system platforms and enabling components to the war fighter. This module is designed to set a theoretical foundation about the AFSC production science to build on with future modules to come.
Without having worked within one of the Air Logistics Complexes, members may have a general understanding of what the depots do but not necessarily how they accomplish their mission to sustain weapon system readiness to generate airpower for America.

This module will provide the theories behind how the AFSC does business. Before exploring these ideas we first need to know why the AFSC operates in this way and additionally why it is important for logisticians in the Air Force to know this information.

Lieutenant General Bruce Litchfield drove the point home best when he remarked, “The size of the Air Force will be determined by the cost of readiness.” and although the depot isn’t the only player in Air Force readiness it does have a substantial dollar amount associated with its operations. If the AFSC’s operations are lean, agile and reliable one can make the cognitive connection to cost effectiveness. In other words, the dollars saved at the AFSC can have a strategic impact. By operating more cost effectively, the AFSC can help increase the size of our Air Force and moreover the Air Power our nation can project which may be the difference between accomplishing our next mission or not. If that mission is a conflict can we really afford to lose? This is the “burning platform” in the AFSC that is driving change.

Bottom line, throughput at the depot is directly correlated to increased Wing-level capability.
In this module I will briefly describe the AFSC way visually and show you the intent behind depot production which is called “the machine” in the AFSC. Next we will discuss what goes into each Machine to include Little’s Law and how to design a machine and its monitoring system.

Additionally, the graphic on the screen is a visual representation of a philosophy that the AFSC exemplifies. As you can see the Mechanic is presented in the center with everything that the mechanic needs to be successful surrounding him or her. It is the responsibility of AFSC leadership at all levels to ensure that the mechanic has what he needs to add value to the customer at all levels of the value stream.

Finally, at the bottom of the screen you will see a banner. Throughout this module, epiphanies will be emphasized here.
This is another visual representation that symbolizes part of the AFSC Way. Again you see that the mechanic is in the center and is being supported by the system. The mechanic is the one that does most of and almost all of the value-added work in the depot’s value stream. Let me direct your attention to the top ring which represents the AFSC leadership model which is also represented by the image in the top right corner. This leadership model defines what the organization values in its units, people, processes and resources all focused around common goals.

Once units and their members understand the organization’s culture and expectations, they need a clear system to help add value to the process. The AFSC “scientific method” helps AFSC Airmen add value while remaining cost effective.

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We will talk more about the scientific method as we go through the module.

Moving to the third ring called Game Plan Integration, you’ll see that this is represented by the “radiator chart” on the right of the screen. This ring represents the merging of the AFSC Leadership Model and AFSC scientific method. The radiator chart depicts the idea that using a scientific methodology to both construct organizational goals and measure progress toward those goals, organizations can achieve Art of the Possible results that positively contribute to the bottom line – the cost of sustainment. These goals are guided by a leadership model that seeks to create a leadership culture in order to leverage enterprise-wide processes and capabilities.

The final ring is the Maturity Matrix. This is how the units rate themselves on their journey towards world-class status for each of the execution horizontal bars in the radiator chart. This allows each unit a method for self-reflection and to communicate to the organization how they are implementing the AFSC Way.

Next, we are going to look at what the Machine is designed to accomplish within the AFSC.
Before discussing the machine it is worth noting that AFMC’s 5-Center reorganization provided the platform to create a common Air Logistics Complex production philosophy among the three depot locations. Additionally, it standardized the organization structure and all three locations are working towards common metrics to increase transparency. Transparency from the ‘shop floor to the Chief of Staff’s door’ is critical to the AFSC way because it allows the organization’s leaders to focus on their people, processes and resources to create value with the greatest impact to our customer, the warfighter.

So what is “The Machine”? Simply put it is the production process for each Aircraft, Exchangeable and Commodities line that the three depots manage and operate. A key element of the environment that the Air Force is operating in today is one of fiscal constraints while at the same time maintaining air power capability. As already discussed, the AFSC’s approach to dealing with this environment is to increase ‘cost effective readiness’. In order to do this each ALC must focus on value to the warfighter, throughput of each production process and constant process improvement.

How does AFSC create and define value for the warfighter?
As companies look for solutions to the problems facing them today, many have come to the realization that all organizational actions must be geared towards adding value from the customer’s perspective. Failure to accomplish this means loss in market share, which if not corrected, will spell doom for companies in a free market.

The depot operates more closely with industry than military field-level maintenance units and thus can gain a lot by looking to corporate business successes for best practices. One such success is the movement towards lean business practices and processes.

The first principle of lean is to identify value which can only be determined by the customer. Then the process is evaluated to determine if it is aligned at every step to create that value. Anything that is not adding value from the customer’s perspective is waste. Removing waste to create value for the customer is what the lean practices are designed to do.

It is also important to note that the best process improvement, cost effective product or flashy new technology means nothing if it does not create value for the customer. Said in another way, if the customer is not willing to pay for what a product line produces, that product is waste.

Now that we have defined value, let’s discuss what this means to AFSC’s customers, the war fighters.
First, every item produced must be a quality product. The ALC’s are working towards a quality reputation that is respected at the field-level rather than being met with skepticism and distrust. Second, the customer wants greater availability of their weapon systems, exchangeables and components. Finally the war fighter wants all of these things cheaper so funds can be spent on other critical mission essential items.

Having an understanding of what the war fighter values, how are AFSC’s production machines working towards creating that value in a cost effective way? To answer that question we have to describe a concept that allows leadership the ability to align resources in their machines to meet production requirements. This concept is called Little’s Law.
Little’s law is designed to show the relationship between three critical performance measures; work in progress or WIP, throughput and flowtime. Realizing that the depots operate in a throughput world, it is easy to see why this concept is so fundamental to AFSC’s success.

Little’s Law is deeply rooted in mathematics but what makes it so powerful is its simplicity and intuitiveness.

The law proposes that at steady state, all production systems have an average throughput, work-in-progress (WIP), and flowtime. The fundamental relationship between all three is determined by Little’s Law: \( WIP = \text{throughput} \times \text{flowtime} \).

Let’s look at each component more closely.
Throughput is the required output of a production machine expressed in units per time.

Flowtime is the average time a unit stays in a production machine.

WIP is the average number of items in work throughout the production machine.

Takt time, which is derived from the German word Taktzeit, translates to cycle time. It is the heartbeat of a production machine and defines how often a single unit must be produced from a machine. Mathematically, it is the reciprocal of throughput. It is determined by dividing the available time by the required output in that amount of time, and is expressed in units of time.

Let's take a look at an example.
If a process is required to produce 37 units in 1 year, the throughput is 365 days divided by 37 units which equals 9.86 days per unit. The takt time would be 10 days. Said another way, every 10 days the machine must produce a unit. It is important to note that all enabling teammates must support this tempo.

This is the conventional definition of takt time...but AFSC has modified it slightly.
AFSC’s modified version of Little’s Law is flowtime equals WIP times Takt time.

Let’s also explore each of these take a ways.

Let’s explore an example of how failing to match your resources with your WIP can create significant priority issues. Imagine a mechanic that inspects multiple types of engine parts. He can only perform three inspections per hour but constantly has a build up of 10 units in his queue. Now this may sound like job security for this individual but it is a definite drag on cost-effective throughput, because all that Work in Queue (WIQ) is money tied up in the system.

Moreover, how does this mechanic prioritize his or her work? Some may say “first in first out” or in other words, place them in a time-received order working the latest part first. Here is where the issue comes in, our mechanic’s friend from the rotor shop asks to have his part moved to the front so that his shop can prevent a work stoppage for lack of material. Then the mechanic’s boss comes down to his area and says “stop what you are doing and work parts 4, 7 and 8 in your queue before you do anything else.” Then he or she gets a call the next day from supervisors of another shop asking why their parts which were scheduled to be inspected three days ago, have not been looked at yet. Can you see how there is no priority in this sort of system as the mechanic puts out the proverbial fires at his or her feet as the building burns down around him?

By using Little’s Law, senior leaders can manage the amount of material or number of units coming into each shop keeping them at a balanced level with the resources available. In an ideal state the inspector would be in a single-piece flow environment were there are no priority concerns because they work the current part and another is delivered in a just-in-time process once the current piece is completed.

So now that we have a basic understanding of Little’s Law, now we can look at how the ALC’s design their production machines.
When designing a production machine there are a few key items to consider during the process. The first thing is that the machine design must take into account value as defined by the customer, often called “voice of the customer”, as well as internal goals which reduce cost or build capacity. This future state will seem unattainable to many, but just like a stretch goal the pressure to attain this new requirement will get people to think outside the box and consider parts of the production machine that may be ‘sacred cows’. This mindset will help to change the culture of the organization to align with lean thinking.

The second key element to remember is that the machine must drive down flowtime and WIP while increasing throughput. By doing this, the production machine becomes more cost effective through more units produced, while inventory and overhead costs decrease. Eli Goldratt proposed that in business there is only one goal for every for-profit company: to make money. Additionally, he boils down the business practices to throughput, investments and operating expenses. He goes on to connect the three by offering that net-profit equals throughput minus the sum of operating expense and investments which is mostly work in progress and inventory.

To increase the AFSC’s cost effectiveness while producing quality products each machine must be designed to increase throughput while decreasing WIP and at a pace that is acceptable to the customer. Lets look at a fictional example of how this would work.
In this example the customer, the aircraft program office, wants 25 aircraft moved through the depot for scheduled maintenance this year. The physical capacity of the facilities dictates that this production line can only take 10 aircraft at a time. With those two variables and using Little’s Law we calculate the takt time and the average flowtime needed to meet customer demand. The takt time is determined by taking the available time and dividing it by the customer’s requirements. So in this example, 365 days divided by 25 aircraft gives you a takt time of 14.6. In other words the production machine should produce an aircraft every 14.6 days. Multiply that number by the WIP of 10 and your average flowtime is 146 days.

Once you have these two numbers the process can be broken out into gates that help to reduce variation in the process by applying lean tools to the management of each gate. In the chart at the bottom, you see each gate broken out with projected flowdays and WIP represented. The WIP for each of these gates is often determined by a physical space constraint but could also be determined by what the customer wants the overall aircraft fleet availability to be. Simply stated, the more aircraft in depot the less aircraft creating airpower for our customer. This is also why the Alc’s are always looking to decrease WIP through increased throughput.

Furthermore, the gate flowtime goals are determined through an iterative process that uses subject matter expert assessments on the gate breakouts for the desired takt time. Additionally, as the gates are monitored, if desired flowdays are met, the flowday target is lowered to continually drive each gate towards additional process improvement.

Once gates are built, leadership must monitor their progress over time. Let’s take a few minutes to examine the gated monitoring system.
To decrease gate variability it maybe beneficial to break the gate into two or more gates which will help in leaderships predictability of the overall production process.
The purpose of the gated monitoring system is to give leaders the ability to track and manage process performance quickly by gathering and presenting data over time.

By gathering this data it allows leaders to ensure that proper resources are available to prevent task saturation and subsequently a loss of material prioritization. Additionally this method also allows for the identification of constraints in each gate which in-turn drives focused CPI events.

This system is designed to create transparency. In the AFSC there is a saying that they want their processes to be transparent from the ‘Shop floor to the Chief’s Door’. The idea being that anyone in the chain of command, even the Chief of Staff can see the depots performance. With that comes the concept that ‘The Red’ is not bad as long as the units are working to fix it. The Red, which includes under-performance, waste, rework, etc. becomes an opportunity to lean the process and reach for perfection.

The monitoring system consists of graphs depicting the performance of a designated amount of items over a period of time. For example, this chart represents the last 10 F-108 engines plus five more that are in-work, but could just as easily be the last 10 C-5 aircraft or other commodity. For items currently in-work, a distinction is made between remaining days and actual completed days in order to determine the projection for each in-work item to complete the gate. The gate monitoring chart also include a green trend line depicting the required performance for the gate as well as a red or orange “last X amount of items” average trend-line depicting the actual performance trend based on the performance of each item. Also on the chart is an inset graph depicting the planned and actual active WIP for the gate. The “Last X Average” is the number of units that would be mathematically representative of the entire population of the product. In this example the representative number is 10.

Lets look at a graph in more detail.
This is a notional gate monitoring chart to illustrate the different components of the monitoring system.

Let's start in the top left corner.

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This small graph shows the planned and actual WIP in the gate. Remember WIP is controlled to align resources of each gate to the required workload.

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As you shift your attention to the larger bar chart you will notice that each notional aircraft is represented by a bar. If complete, the bar will be a solid darker blue and if there are still tasks to be accomplished the bar will show two-toned with estimated remaining days represented in the lighter color.

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Additionally there are two trend lines, the green represents the organizational goal which is 36 days. Remember this goal is designed to stretch the organization and drive towards process improvement. The red line shows the last five average flowdays for each aircraft. This is important because it quickly shows leadership if the gate is trending in a positive or negative way. In this notional gate it is clear to see that the red trend line is moving in the wrong direction. With this information leadership can focus lean experts at this gate to achieve process improvement and remove waste to increase throughput.

Next, let's look at a real gate and examine it using these tools.
As previously mentioned, key aspects of the monitoring system include the performance trends of the aircraft through the gate as well as control of the active WIP within the gate. Let's look at an actual chart that the OC-ALC uses to assess its KC-135 Gate 3. When reviewing this monitoring chart, focus on the location of the red last-10 average trend line in relation to the green requirement trend line:

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Is the trend increasing or decreasing in flow days? How far apart are the red and green trends?

Also review the planned versus actual WIP in order to determine if the active WIP for the gate is being controlled.

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Remember the planned WIP is determined by applying Little’s Law and as you can see the Actual WIP is double in this gate. Leaders can quickly see that production is going to suffer because the resources are spread too thin for the desired performance. This is also identified as you look at the aircraft still in the gate as their projected gate completion date is over the requirement and trending in the wrong direction.

When monitoring the flowtime through a Gate, it is important to drive Continuous Process Improvement (CPI) to the processes in the Gate as opposed to focusing on the individual unit that is flowing through the Gate.

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The star bursts allow senior leaders a quick snapshot of the CPI being accomplished in each gate. By providing this information the whole enterprise that supports that gate can buy-in to the value the CPI will bring. In the example above it is easy to see the trends in the Gate flowtime performance and the CPI initiatives (starbursts) intended to reduce flowtime. This CPI is a value stream map on the aft terminal fitting. If a Gate is not performing at its required flowtime, CPI must focus on waste removal, concurrency opportunities, and constraint resolution.

As you can see this type of monitoring is so important because it brings transparency to the depot process.
In summary, it is the mechanic that adds value to each of the ALC’s customers, the war fighters. Additionally, remember that “throughput is king”, and to reach improved throughput the depots must increase speed, safety and quality. Finally, continuous process improvement is the engine that moves the ALC’s to cost effective readiness.