JUST-IN-TIME LINE OF BALANCE (JITLOB) [1]

Dr. Kenneth Smith, PMP

JITLOB is an enhancement to the **Critical Path Method (CPM),** using ***Cumulative*** **critical path analysis** in conjunction with **Line of Balance (LOB)**[2] -- *a traditional* ***production-line*** *planning technique* -- to improve scheduling & monitoring of **repetitive-type projects and processes**.

The **Critical Path Method** has been recognized since the early 1960's as the "**Best Practice**" technique to plan, schedule, monitor and manage complex ***"one-off"*** Projects -- *i.e.* where ***only one pass through the network*** completes the project. But the acclaim and subsequent clamor for **Critical Path** almost completely eclipsed awareness and application of the **Line of Balance** technique for managing ***repetitive-type projects & processes*** -- even though **LOB** preceded **CPM** by almost 20 years!

LOB continues to be used in some **infrastructure** applications, but the international **Project Management Institute (PMI)®** has ignored it -- perhaps because manufacturing terminology **'*Line of Balance*'** fails to convey the core concept of ***'Just-in-Time'*** **scheduling** it embraces. Consequently, most **PMPs** and other personnel schooled by **PMI's "PMBOK©"** have never been exposed to **LOB** technology; so succeeding generations of Project Managers in sectors other than construction are completely unaware of it.

Nevertheless -- despite being overshadowed and rendered dormant by **CPM's** advent -- **LOB** is a **"*Much Better Practice*"**[3] for planning & monitoring repetitive-type projects than now-conventional critical path methods, as it can significantly reduce overall project durations & costs.[4]

---

[1] How to cite this article: Smith, K. F. (2020). Just-in-Time Line of Balance, *PM World Journal*, Vol. IX, Issue X, October.

[2] **Line of Balance (LOB)** was conceived by **George Fouch**, General Manager of the Goodyear Aircraft Corporation in 1942 to **optimize mass production scheduling** of World War II war materiel for the US Navy. **LOB** was subsequently adopted by the US Defense Department in 1947 and applied extensively to military logistics management when **Fouch** was appointed Deputy Assistant Secretary of Defense for installations & logistics.

[3] In 1961, as a US Navy Management Intern with the **Bureau of Weapons,** I learned **LOB** from **Art Gehringer**, and **CPM** from mentor **Tom Ensor** of the **Special Projects Office**; then applied them *on-the-job* – along with other techniques -- through 1963 as a management analyst in the **Navy Management Office (NMO)**. Subsequently -- for two years (1964 & 1965) under the direction of **Guy Best** -- as a management systems specialist & faculty member cum consultant of the interagency **Pert Orientation & Training Center** (**POTC**), I fostered the use of **CPM** & **LOB** throughout the US government, as '***Best's Practices***.' Since then, I have applied both techniques on numerous projects in different sectors -- *as well as taught them* -- world-wide, for various international development agencies and **PMI®** chapters.

[4] For example, an **eleven-week process** consisting of three activities -- ***2, 6, and 3 weeks respectively*** -- would take **55 weeks,** if repeated sequentially five times. But **optimally 'balanced'** as **eleven one-week activities**, the process could be completed in **only 15 weeks!** Even **sub-optimized LOB** scheduling – *i.e.* retaining the sequence '***as is***' -- would accelerate the process to **35 weeks;** ***still a significant 36% percent schedule improvement over sequential processing; as well as 20 weeks of savings in indirect costs!***

Furthermore, most sectors have projects or component processes that are totally or partially repetitive in nature, so the possibilities for deriving such scheduling and cost benefits with sub-optimal **LOB** applications are widespread.

Therefore, although this presentation is not '***timely,***' hopefully re-designated as "**JITLOB"**[5] and disseminated *de novo* as an ***enhanced* Critical Path** application, awareness of **LOB** concepts within today's project management community will be heightened, and its use in scheduling, monitoring & managing repetitive-type projects & processes will increase commensurately with the generic **template** illustrated herein.

Here then -- *Better Late than Never* -- is "*Just in Time* Line of Balance" (JITLOB)

CPM RECAP

During planning **"one-off"-type projects, their activities** and **milestones** are identified, and bounded by **Start** and **Completion Milestones,** and their sequential interrelationships & duration are further refined. Once this has been accomplished, the key series of activities that determine ***how long*** it is likely to take before the entire project can be completed is designated the '***critical path.***' The project's sponsor may then accept this *'technical/engineered'* estimate, or alternately impose a different — *often a tighter* — deadline (or target) for the Project Manager to attain. The planners then reexamine the project, focusing on **critical path activities** and weighing alternatives for completing the project by the deadline.

REPETITIVE PROJECTS & PROCESSES

Essentially, the **end objective** of **repetitive** projects and processes is **multiple unit production**; attained by passing through a particular **predetermined** sequence to complete an **End Item Unit (EIU),** then **repeating the cycle many times. To cite just a few examples:**

- In a suburban **housing construction project**, a **CPM** network can be developed to outline the process for building one house; ***but the larger objective is to build many standardized housing units during the project's life-span*.**
- In **a highway project**, a standardized **process** to construct one kilometer *(or other meaningful segment -- dependent on the labor, materials and equipment available)* -- is ***repeated over and over again*** until the planned destination is reached.
- In **a high-rise building project**, the interior layout & construction, utilities and furnishings of many of the higher floors is similar to that of the lower floors.
- In **agriculture**, the **process** for producing and marketing a crop (i.e. rice) can be networked with **activities** such as planting, weeding & harvesting, with requisite seed, fertilizer, pesticides, water and labor **inputs** phased in at predetermined stages. Sometimes, ***start-up* planting of many hectares can be staggered** over a period of

[5] Rather than simply supplanting and pretentiously '***reinventing***' it, '**Line of Balance'** retains **George Fouch's** antecedent designation for his manufacturing planning technique and its subsequent adaptation for infrastructure projects. The '**Just-in-Time**' prefix in this update connotes a ***reverse-scheduled Cumulative Critical Path*** concept, to highlight **LOB**'s relevance to planning & scheduling **other** types of Projects ***of the Repetitive kind***.

several days or weeks, based on availability of labor and other resources; resulting in an **extended duration** for harvesting and marketing.[6]

- In **banking**, the loan application **process** for obtaining a mortgage entails numerous interrelated, dispersed, activities. **Subsequent individual applications for approval are repetitive.** Monitoring the status of all 'in-process' applications at different stages of accomplishment is therefore an important management ***'need to know'*** function.

PLANNING REPETITIVE PROJECTS & PROCESSES with CPM – TODAY

The prevailing approach to managing repetitive-type projects and processes is either to **treat each end item in the project as a sub-project** and monitor the production & completion of each unit **separately**; **or** alternately, to **summarize & visualize the repetitive aspects as a single bar** on a high-level Gantt chart, then estimate and monitor its percentage of completion.

Progress is then measured during implementation at various time intervals, based on the **percentage of activities completed and their relative durations** -- ***plus incremental estimated proportions of on-going activities*** -- compared to the plan.

Both approaches are **unnecessarily *inefficient.*** It is very *cumbersome* to monitor each sub-project separately, and summarize the data at the Project Management Office (PMO) for higher executive levels &/or 'need to know' customers.

Furthermore, it is also ***ineffective*** to monitor repetitive activities by incremental percentage '*ceiling'* estimates.[7]

IMPROVED REPETITIVE PROJECT & PROCESS PLANNING -- with JITLOB

Line of Balance, on the other hand, can integrate repetitious activities efficiently and highlight the project's key milestones for very effectively monitoring by identifying a '***Cumulative Critical Path*'[8] –** which it displays in concise graphs and tabular reports.

In manufacturing, the production line design objective is to '***balance***' the work stations optimally – *as much as possible* -- with **equitable time durations for each activity** so that work flows smoothly throughout the entire process. To that end, unique, **individuals or teams are assigned to each workstation.** [9] **For repetitive project processes** however, process scheduling can only be ***sub-optimized*** because **most activity durations have to be accepted**

---

[6] But — *unlike infrastructure projects where lack of inputs can hold up the process indefinitely, then resume only slightly impaired* — the agricultural season doesn't stop, so when farming activities aren't done on schedule it is often impossible to resume without substantial shortfalls in the quantity & quality of the yield anticipated earlier. [All too often, the ***lack of forward planning*** to procure inputs in a timely manner for medium- and large-scale agricultural programs and projects results in late deliveries and servicing activities.]

[7] I.e. Look at the ceiling and posit a guess!

[8] LOB predated CPM, so the term '*Critical Path*' was not yet applied to the concept.

[9] Dedicated individuals or teams for each activity are a key aspect of production line balancing by **LOB,** and **Kanban** – another manufacturing workflow system developed in the late 1940s by Japanese engineer **Taiichi Ohno,** and popularized as the **Toyota Production System** (Ohno, 1988).

'*as is.*'

Nevertheless, each repetitive project **activity** should still be similarly **modularized,** with a **unique team assigned,** subject to availability of resources. Individuals should not be assigned to more than one such activity, or interchanged; so subsequent repetitions of the same activity are precluded from being undertaken ***concurrently***.

In the repetitive process – ***rather than activity durations*** –**milestones in the network of activity interrelationships are the basis for monitoring** the 'throughput' of all items at intermediate stages, and the percentage of completed milestones unequivocally indicates the project's performance status. **Thus, it is imperative that each and every activity in a repetitive-type project have both a predecessor and successor milestone.**

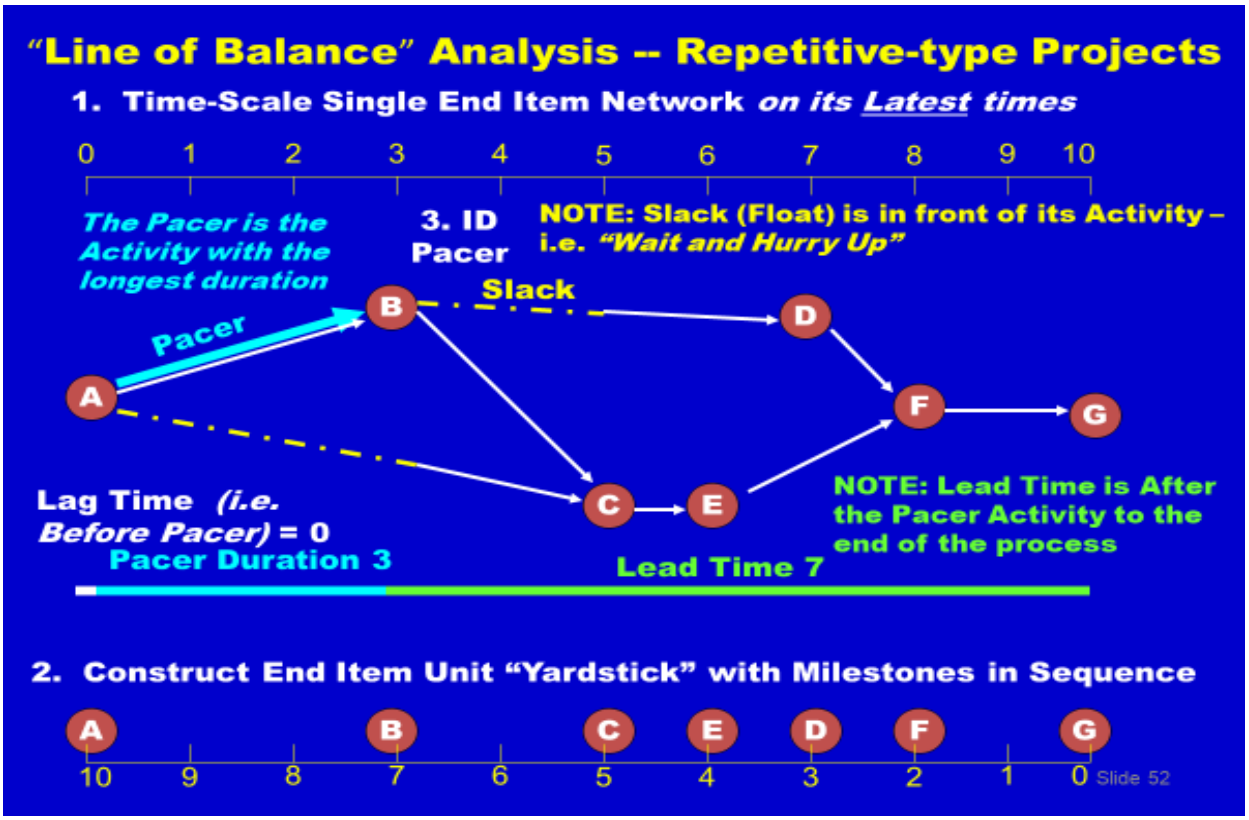
Then -- just as with "one-off" projects -- **time duration estimates are developed for each activity (*or each cluster of interrelated contiguous tasks is consolidated and summarized as an activity*)** for scheduling; although activity durations in repetitive processes are usually more predictable.

The **Project Process Network** (called a **Production Flow Plan)** for the **initial End Item Unit (EIU)** is then developed in a comparable manner to *"one-off"* projects. However – ***differing from 'one-offs'*** – with JITLOB, after the ***critical path*** has been determined, all activities and milestones are ***scheduled backwards*** on their ***latest time*** estimates – *i.e. as late as possible (**ALAP**)*[10] -- with any "slack/float" up front. In this manner, the activities are planned to be completed '**just in time,**' and ***time-scaled*** as illustrated in **Figure 1** on the following page.

[10] All activities are scheduled **ALAP** – *i.e. "wait & hurry up" (as opposed to the "hurry up and wait" of 'one-off' projects)* **--** to minimize the necessity for stock-piling, inventory, storage facilities &/or security.

1. Production Flow Plan

FIGURE 1



The time duration after the **Start** of the project process cycle, *until a particular milestone will be reached*, is designated **"Lag Time." A reverse time scale** from the end of an EIU to its start -- *in effect the duration **after** a milestone until the **end item unit completion*** -- is **"Lead Time."**

In this manner, **every milestone is prepositioned in the process in terms of its Lag and Lead Times.** The **activity** with the **longest duration** in the project process network is identified as the "**Pacer**" activity. [If more than one activity is equally as long, only **designate one** of them as the **Pacer**.]

The "Lag time to the Pacer *(which may comprise several activities)***, plus the Pacer duration, and Lead time after the Pacer** *(which may comprise several more activities)* **to completion of the EIU"** constitutes the **EIU '*Critical Path*;'**[11] with other activities preceding, concurrent, and succeeding the **Pacer** in a '*wait & hurry up*' **ALAP** mode.

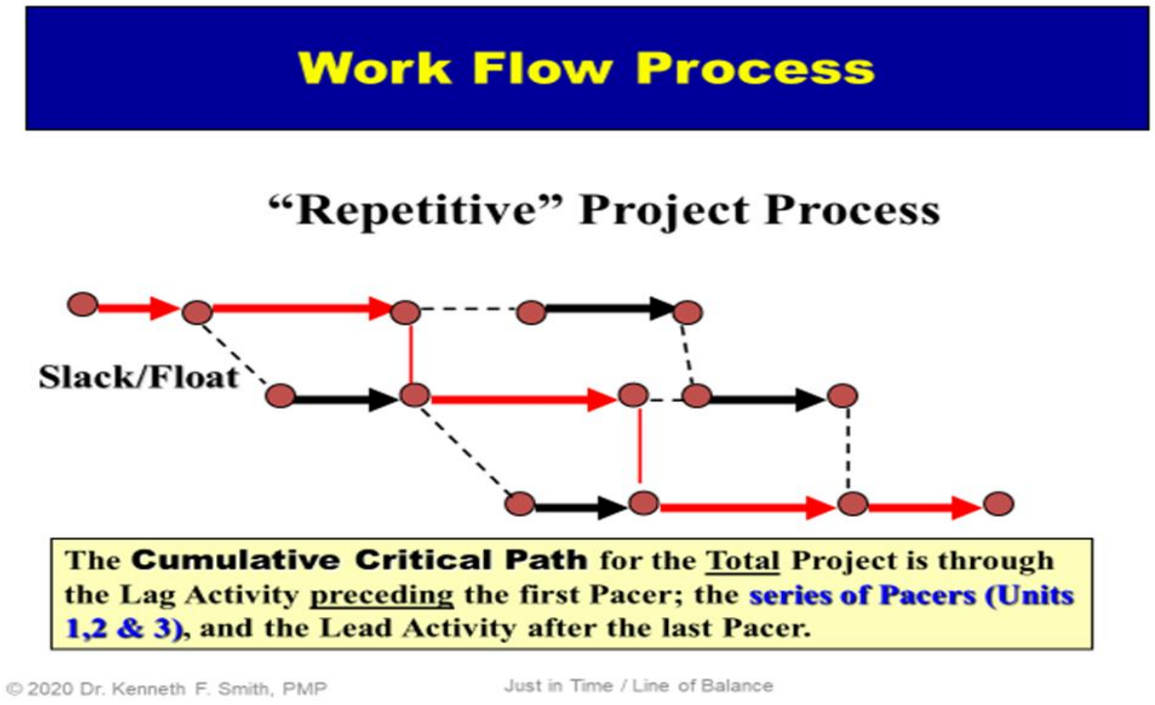
The milestones and duration for completing one EIU are then summarized and represented on a single bar – designated a "**Yardstick**."

[11] AKA "***Cycle Time***" or "***takt time***" in **Kanban** system applications. [**NOTE:** Since all activities are scheduled **ALAP**, actually every activity is now "**critical.**"]

Within this EIU cycle, the Pacer activity is the key constraint for subsequent repetitions.

The **"*Lag time to the first Pacer, plus the Pacer duration multiplied by the number of desired repetitions, and Lead time after the last Pacer to completion of the last EIU*"** constitutes the **'*CUMULATIVE CRITICAL PATH*' for the entire project,** as indicated in **Figure 2.**

FIGURE 2



Any delay in Lag activities on the EIU Critical Path, the Pacer Activity start, &/or its duration, or subsequent Critical Path Lead time activities will delay **completion of the EIU,** while any delay in the Pacer will delay the onset of the **next EIU Pacer.**[12]

Thus, the following six (6) '**Crucial**' **milestones** on the **Cumulative Critical Path** are the **Key Performance Indicators (KPIs)** to monitor during implementation:

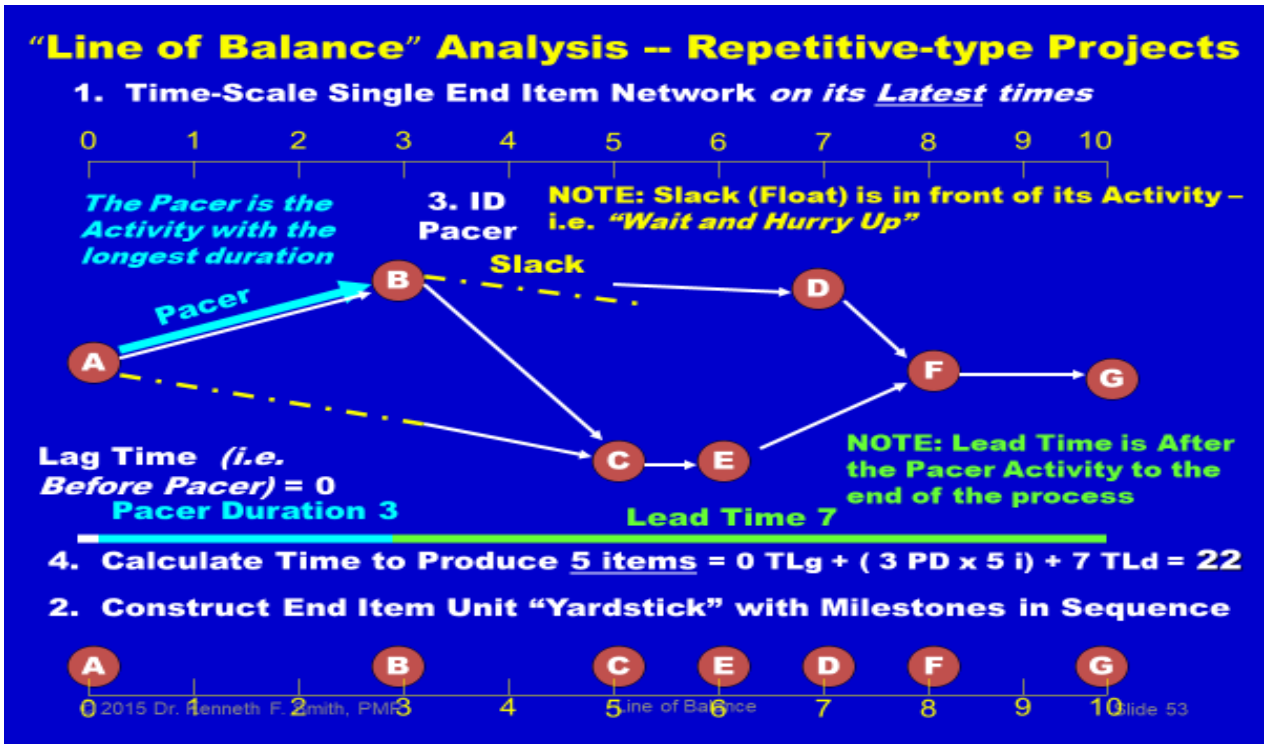
1. Start of the series of Lag Activities
2. Completion of the series of Lag Activities

3. Start of the Pacer Activity [*Initially assumed concurrent with Milestone 2*]
4. Completion of the Pacer Activity

5. Start of the series of Lead Activities [*Initially assumed concurrent with Milestone 4*]
6. Completion of the series of Lead Activities [*i.e. EIU Completion*]

[12] However, it is also important to note that **end item units do not have to be completed before subsequent EIU activities can start.**

FIGURE 3



Once a repetitive project process model has been prepared, **feasible production capacities** and **deliverable capabilities** can also be estimated by formula — for any time period, as shown in step 4 of **Figure 3** above and discussed further below.

FEASIBILITY ESTIMATING WITH JITLOB FORMULAS

The Pacer Activity duration, coupled with its predecessor **"Lag Time"**[13] and successor **"Lead Time"**[14] determines the duration of the overall project's **Cumulative Critical Path**.

Feasibility analysis is then undertaken to determine either the:

1) **Time required *to produce a given number of end items***; or the

2) **Number of end items that can be produced *within a particular time period*.**

Given the Lag, Pacer and Lead duration information, and the ***number of end-item repetitions*** desired, the project's **overall Cumulative Critical Path** and its ***duration*** are then identified, and can be calculated by using one of the following formulas.[15]

[13] i.e. from the beginning of the unit "Start" milestone until the Pacer starts

[14] i.e. after the Pacer is completed until the **Unit's 'end item'** milestone is "Completed"

[15] The minimum duration is where **N=1** (i.e. a ***"one-off"*** *— rather than "repetitive" type —* project.)

1. Time Required to Produce a Given Number of End Items[16]

A ***"Critical Path"*** computation determines the total project schedule for *"one-off"* projects. For ***"repetitive-type"*** projects, the **Cumulative Critical Path** is computed with **JITLOB** to **determine *the time required* to produce any number of end item units**, as follows:

Estimated Time Required = Lag Time + (Number of End Items x Pacer Duration) + Lead Time

Example: Given

Lag Time	=	3 weeks
Number of End Items	=	8 units
Pacer Activity	=	5 weeks
Lead Time	=	1 weeks

Then Estimated Time Required is **3 + (8 x 5) + 1 = 44 weeks**

2. Number of End Items that can be Produced within a Given Time Period[17]

If the overall estimated Time Required is longer than desired, the following formula can be used to **determine *how many items can be produced*** within an overall project assigned duration, or **"deadline:"**

$$\text{Number of End Items*} = \frac{\text{Assigned Time - (Lag Time + Lead Time)}}{\text{Pacer Activity Duration}}$$

[***Round Down to the next whole Number***]

Example: Given

Assigned Time	=	40 weeks
Lag Time	=	3 weeks
Lead Time	=	1 week
Pacer Activity	=	5 weeks

Then the Number of Items that can be Produced is $\frac{40 - (3 + 1)}{5}$ = **7** (rounded down)

[16] Assuming a separate work crew is assigned to each activity. If additional complete crews (or production lines) are available to do all the work concurrently, **divide** the ***time required*** by the ***number of complete crews***. **Also consider sub-dividing the Pacer Activity work between two or more separate crews.** This will have the effect of changing the **Pacer** to a ***different*** activity, which in turn will reduce the overall time to produce a given number of end items.

[17] Assuming a separate work crew is assigned to each activity. If another complete crew is available to do all of the work concurrently, **multiply** the ***number of items*** by the ***number of crews*****. Also consider sub-dividing the Pacer Activity work between two or more separate crews.** This will have the effect of changing the **Pacer** to a ***different*** activity, which in turn will increase the number of end items that can be produced in a given period of time.

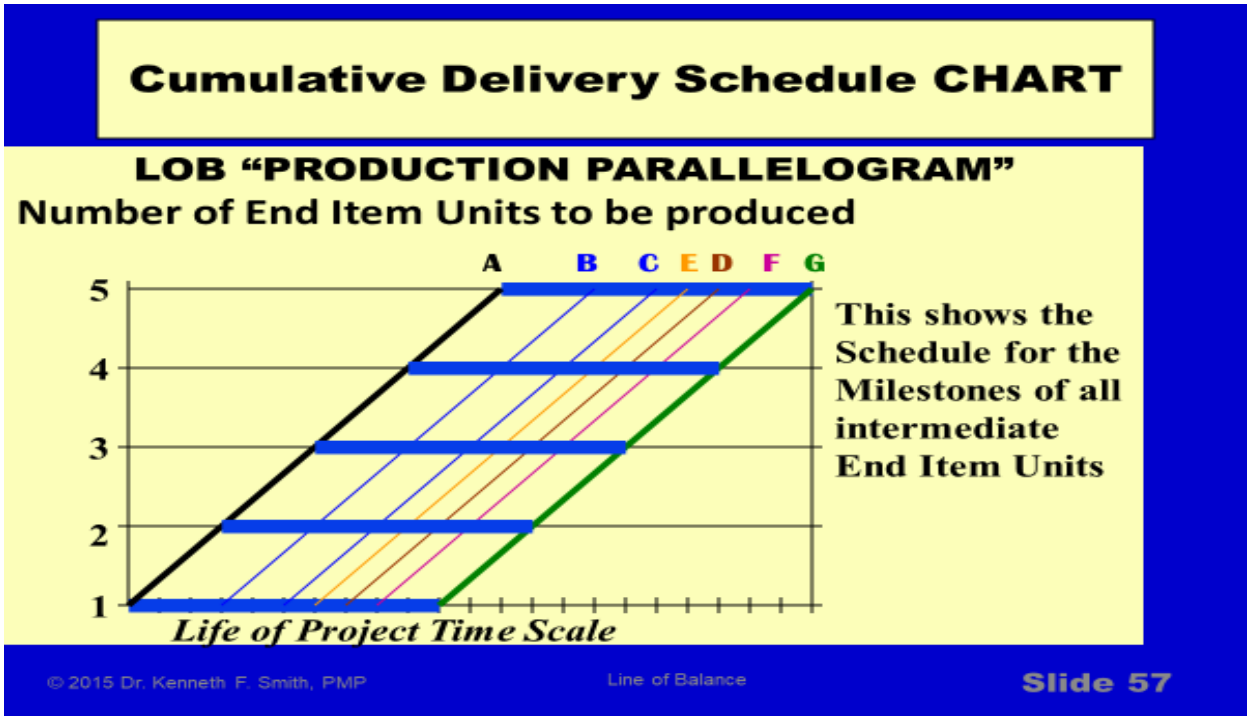
A Project Manager is usually given a start time and an overall time limitation to complete all end-units. However, there are two major constraints which could make the desired schedule infeasible:

1. ***Internal*** **logical** ***dependencies*** **in a particular process as indicated by the network**
2. **The number of** ***concurrent processes*** **operated under the project.**

Due to different elapsed times for various activities, bottlenecks -- ***with ensuing dead-time or delay time*** -- can occur for subsequent activities in the process. With the foregoing formulas, trial & error simulation can be employed to explore all possibilities.

For scheduling purposes, in addition to the aforementioned **Production Flow Plan** for the process, **JITLOB** uses a **Cumulative Delivery Schedule chart** for scheduling & monitoring the overall project, as illustrated in **Figure 4**; and discussed in more detail on the following pages.

FIGURE 4



If the desired production schedule is linear, after obtaining the project duration for the requisite number of end items, place the last milestone of the project yardstick for the last **EIU on the upper right.** Then construct a line joining the common points plotted for the first and last milestones.[18] ***In effect, each End Item Unit's "Start" and "Complete" milestone schedule is interpolated directly.*** For each of the milestones to be monitored, add parallel sloping lines traversing the intermediate *End-Item Units* on the **"Y"** Axis.

[18] **NOTE:** *If the* ***start-up or desired*** *production schedule is* ***erratic***, the 'ruler' must be applied and plotted separately to *each End Item Unit*, before joining the common points. [*The JITLOB Template can also accommodate this.*]

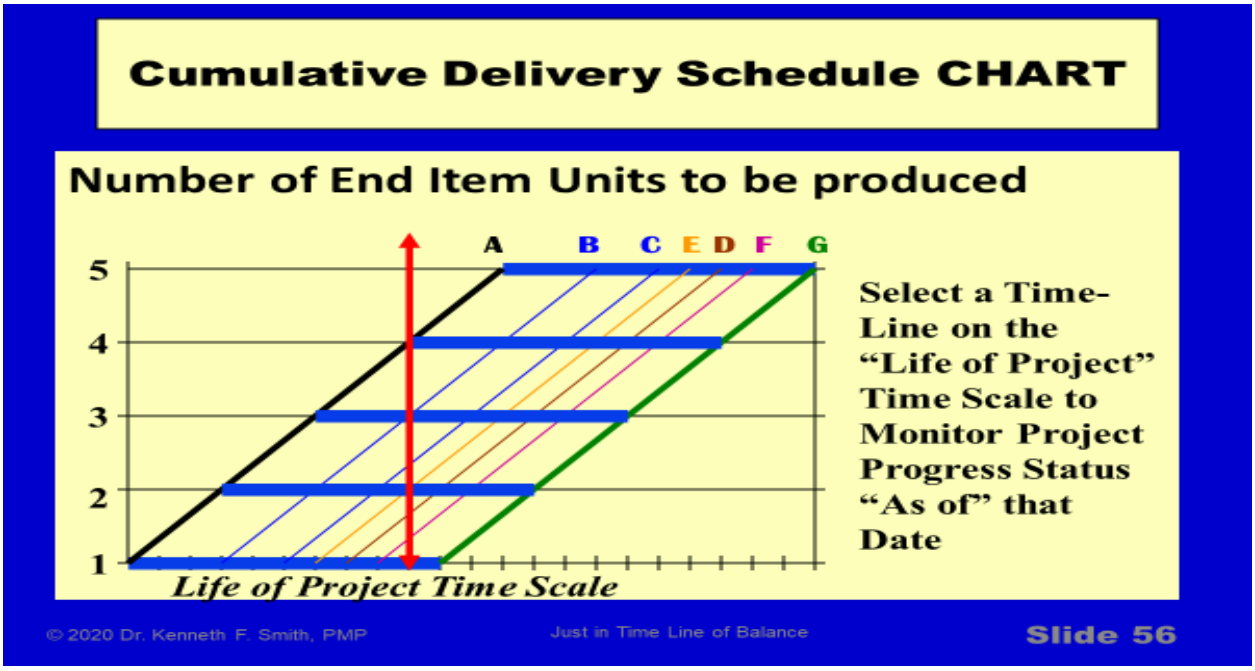
Figure 4 captures the overall project's feasible repetitive *End Item Unit* **(EIU)** production schedule in one chart -- a **"Production Parallelogram."** It indicates the *number of times each activity in the network must be recycled,* as well as the *timing*. The cumulative number of units to be produced[19] — *i.e. the number of repetitions and duration required for "A" through "G" in the example* — is shown on the ***"Y"*** *axis,* while the *time period for the total project* is indicated on the *"**X**"* axis.

MONITORING WITH JITLOB

Figure 4 shows the number of milestones of **each EIU** planned, and the overall schedule. [*Actually, many more milestones could be monitored in this manner, not just the* **'Crucial' Cumulative Critical Path** milestones.]

Monitoring the status of multiple EIU's at any time – i.e. those *which should have been completed as of the reporting date* in order for the overall project to be on schedule -- is now relatively easy with **JITLOB**, as illustrated by **Figure 5** below.

FIGURE 5



To be on schedule, the *desired production level* for the overall project as of that date is where the reporting date line crosses the **"Y"** axis of the sloping line activity milestones for each **EIU**.Those *on and to the left* of the red time-line should have been completed.

[19] **NOTE: It is important to *express all units in terms of the network end-item*.** For instance, if the project is an agricultural one with the objective of harvesting a number of hectares, all intermediate milestone units should also be expressed in hectares. Seed requirements, fertilizer, credit, labor and other inputs would then be computed in *"**per hectare**"* units. A conversion table for each milestone in terms of the network End-Item unit should also be prepared for ready reference.

Data is then collected from the supervisor of each activity team '***as of***' the reporting period, and reports made indicating the *cumulative number of times each activity and/or milestone in the network is started and/or completed.* The reason for any variance, as well as required actions for rectification – if any – should also be noted.

FIGURE 6

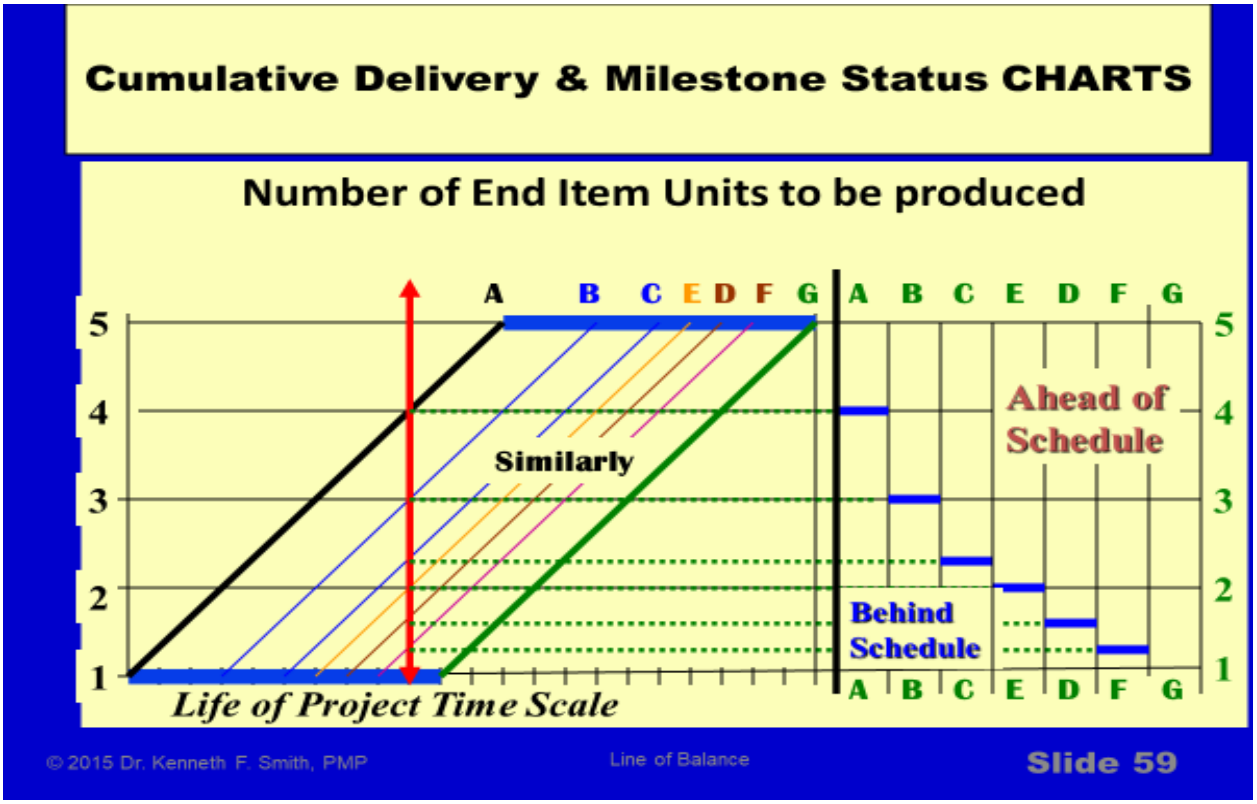
TYPICAL JITLOB STATUS REPORT		**AS OF WEEK "xx"**	
MILESTONE	CUMULATIVE NUMBER PLANNED	CUMULATIVE NUMBER COMPLETED	**NOTES**
A Start Lag	**4**	**3**	**One time event. Breakdown in equipment. Estimate 1 more day needed to get operational again.**
B Complete Lag	**3**	**3**	
C Start Pacer	**2**	**2**	
D Complete Pacer	**2**	**2**	
E Start Lead	**1**	**1**	
F Complete Lead	**1**	**1**	
G Delivered	**0**	**1**	

Plan & Progress Status Chart

If desired, a graphic Plan & Progress Status chart can also be developed as a ***histogram*** at the right side of the Cumulative Delivery Chart, with the milestones listed along the "X" axis from left to right, in order of completion on the 'time-line.'

The scheduled status for each Milestone is an irregular stair-step effect projected from the intersection of the time line and milestone *'**as of**'* any particular date depicted by the red arrow Time Line. This is illustrated in **Figure 7** on the following page.

FIGURE 7



During implementation, the status of multiple activities in various stages of completion can be readily assessed from **Figure 7** to determine:

1. **CURRENT STATUS:** Whether or not ***Overall Performance*** is ***On***, ***Ahead***, *or* ***Behind Schedule***

2. **CURRENT CONSTRAINTS:** Where any ***bottlenecks*** exist, as well as

3. **FUTURE PLANNING:** Potential ***impact*** on ***total project completion*** either in terms of ***time or quantity*** of ***"end items"*** produced.

JITLOB Analysis

- Where **Actual and Desired Lines coincide,** the project's rate of production is ***"on schedule,"*** or in balance.
- Where **Actual is higher than a Desired Line**, production is ***"ahead of schedule."***
- Where **Actual is lower than a Desired Line,** production is ***"behind schedule."***

By reviewing actual status in the histogram from left to right, ***the first milestone falling below the line is the most critical one,*** causing delay in meeting the **immediate** production schedule. The activity preceding this milestone represents a bottleneck in the entire production process. Its slow performance — *for whatever reason* — will delay, or denigrate, the quality of subsequent activities and milestones. Unless rectified, it will ultimately have a 'domino' effect rippling

throughout the whole project. The potential impact on the overall project can also be identified by simply projecting *"behind schedule"* milestones, as shown in **Figures 8 & 9.**

FIGURE 8

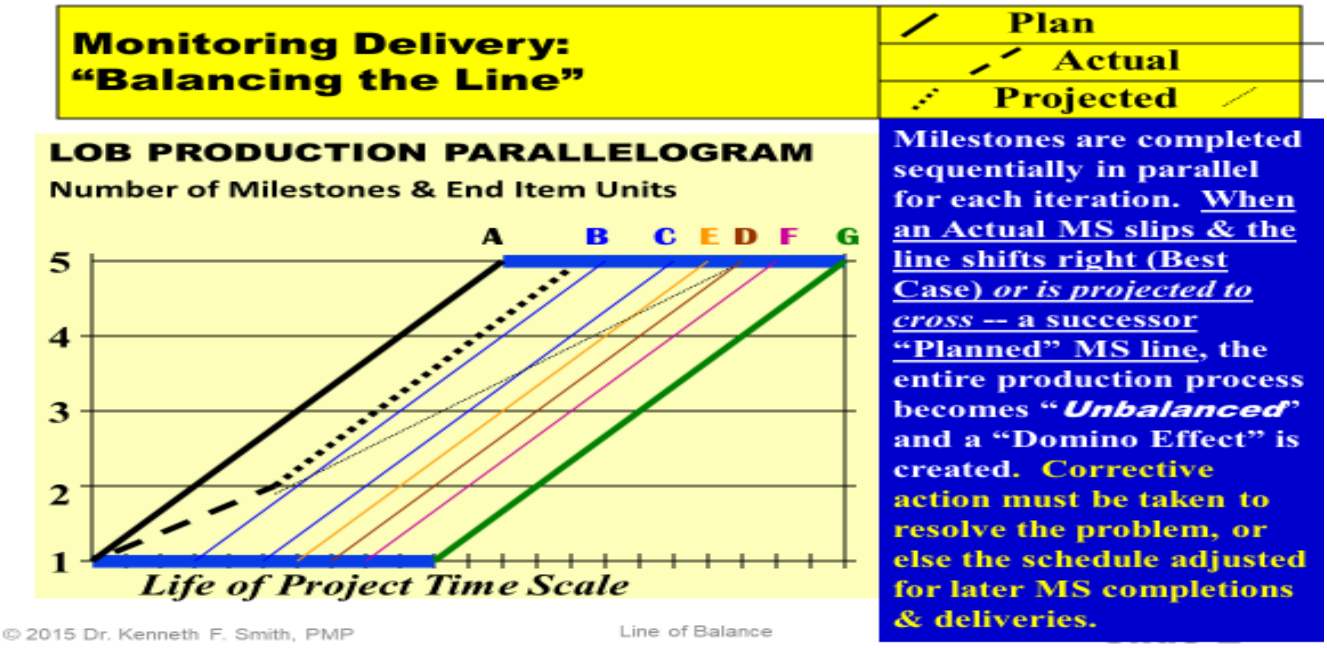
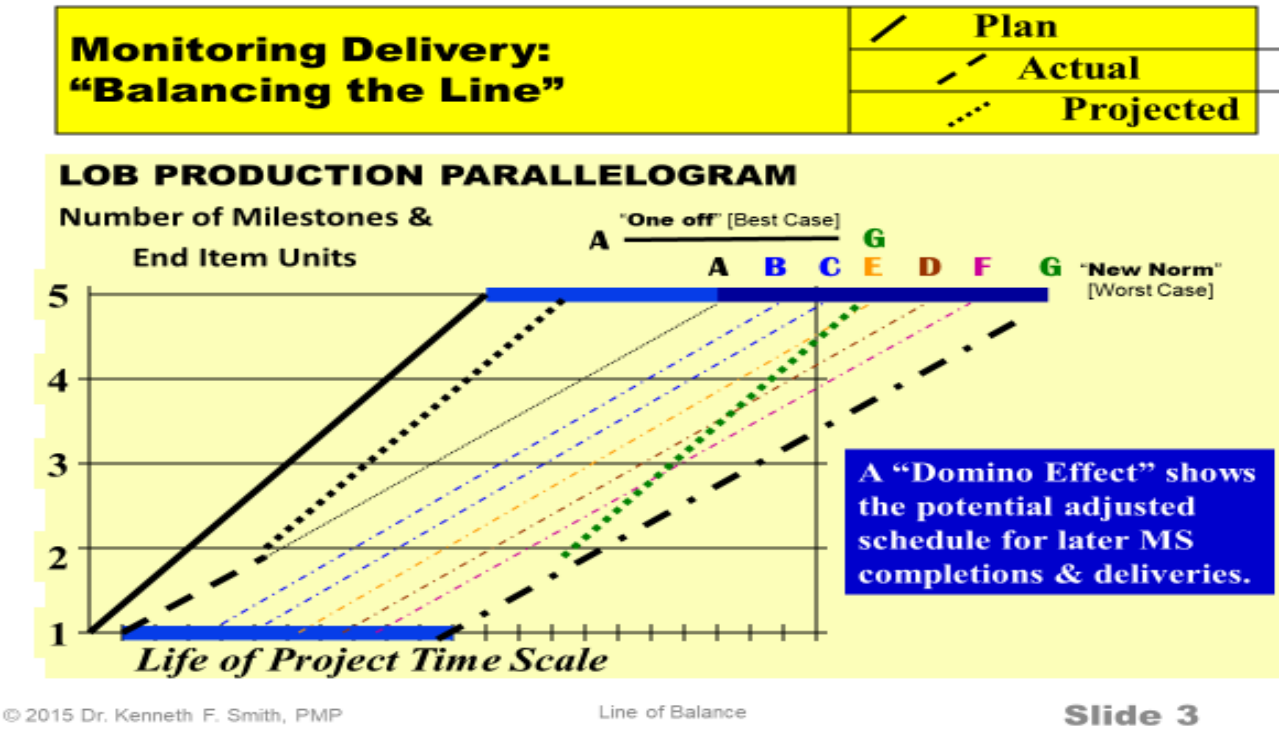


FIGURE 9



MANAGEMENT ISSUE

"*A chain is only as strong as its weakest link.*"
Similarly:
A repetitive process is only as fast as its slowest *Pacer* activity!

Once schedule slippages have either been identified or projected, the issue for Project Managers is to determine whether the delay is a '***one off***' anomaly that can be immediately rectified &/or mitigated in the near future; or a '***New Norm***.'

If a 'one off,' several options may be available: i.e.

- Work overtime, weekends &/or holidays to 'catch up' and get back on track
- Crash future repetitions of the Activity by applying more resources
- Obtain more resources to run a double, or even triple shift, and/or
- Run a parallel 'fast track' or tracks

on slipping, and subsequent activities;

- **Or Crash the Pacer**, so it – ***or another activity*** -- becomes a new ***faster*** Pacer.

[NOTE: If two or more Activities are equally lengthy, only one is designated the Pacer. However, when Crashing, **all** such Activities must be Crashed simultaneously.]

If a 'new norm.'

- Accept the reality of the production and delivery schedule forecast
- Obtain and issue a change order for the project

and notify the activity supervisors, executives, customers and other stakeholders.

COMPUTER PROGRAM LIMITATIONS

Although unique applications of the **LOB** technique have been developed for some specific project applications, **unlike Critical Path** – *for which several generic scheduling software (such as MS Project, ProjectLibre and Primavera) exist* – **no such generic computer program is currently available for Line of Balance.**

A cumbersome '***workaround***' for MS Project -- *and presumably other software* -- is to:

- assign a **unique resource code** to each activity,
- **indent each EIU** (as a work breakdown structure level) on the **Gantt** chart, and
- **copy & paste** the production plan network **for each EIU** desired.
- **Link each repetitive activity successor** to its predecessor activity in the previous **EIU**
- **Apply the 'leveling' function,** so repetitive activities are not concurrently 'fast tracked.'

I tried this approach on several projects and sub-processes in the past**.** Although activities & milestones can be scheduled on their latest times, data entry is laborious, and the ensuing network, cumulative Gantt delivery graphics and reports are voluminous – *even for a relatively small*

project process with only four repetitions. Unfortunately -- *unlike the compact **LOB** charts depicted in this article* -- those reports and graphs are not conducive to rapid comprehension and analysis.[20]

Consequently, throughout my 'on-the-job' working life, after using critical path project software for **EIU networking, critical path computation** and **ALAP milestone scheduling**, most of my applications ***for dozens of diverse projects in a variety of sectors*** were pencil-driven, with a plastic template to draw symbols, and ruler & graph paper for manually-drafted charts. These diagrams were then blueprinted, or reproduced by photo-copying, for distribution.

However, a company is currently working on an interactive **JITLOB** software for me.[21]

NEW (2020) DEVELOPMENT: 'KENJIT' – AN EXCEL TEMPLATE FOR JITLOB

In the meantime, to overcome the foregoing deficiencies in repetitive project scheduling & monitoring, and take **LOB** beyond '***nice-to-know***' theory, I recently created an **Excel Template** for '***on-the-job***' **application** processing data for the **six (6) 'Crucial' Cumulative Critical Path milestones;**[22] **JITLOB's Key Performance Indicators (KPIs):**

1. **Start of the series of Lag Activities**
2. **Completion of the series of Lag Activities**
3. **Start of the Pacer Activity**
4. **Completion of the Pacer Activity**
5. **Start of the series of Lead Activities ASAP**
6. **Completion of the series of Lead Activities ASAP [*i.e. EIU Completion*]**

Plus:

7. **Start of the series of Lead Activities ALAP, and**
8. **Completion of the series of Lead Activities ALAP [*i.e. EIU Completion*]**

The **JITLOB** Template generates a summary **production parallelogram chart** with a **forecasting** feature similar to **Figure 9. [NOTE:** I *dispensed with the optional cumulative delivery milestone status histogram* (Figure 7); but crucial milestone status data -- *by date* -- is retained in matrix charts.]

Highlights of the **JITLOB** Template – which I dubbed **"KENJIT"**[23] -- are shown on the following pages.

---

[20] **Excel** or project software **Gantt Charts** display **each activity** and **milestone** on a **separate row.** For a repetitive project, the **total number of rows** is the **sum of activities and milestones** in an **EIU *multiplied*** by the ***number*** of **EIUs –** which entails the chart being displayed over **many pages.** By contrast, an **LOB *Production Parallelogram*** is much more compact as **each EIU is only one row**, with the **milestones time-scaled on the EIU 'yardstick.'**

[21] I will advise **PMWJ** when it is available.

[22] Serendipitously, I re-learned the value of the '***Forest & Trees***' adage – namely that limiting the graphic to only the **six Crucial Milestones** actually **improved visibility *at the higher level*** by reducing the **clutter** that would otherwise result from plotting ***all*** the milestones in the project process.

[23] For pride of authorship

JITLOB Planning

Project Identification & planning data is entered in the **ten (10) yellow cells** below.

FIGURE 10

JUST-IN-TIME/LINE-OF-BALANCE (JITLOB): PLANNING, SCHEDULING & MONITORING
KEY PERFORMANCE INDICATORS (KPIs) of REPETITIVE-TYPE PROJECTS

A. FEASIBILITY ASSESSMENT PLANNING: ENTER DATA IN YELLOW CELLS				**"KEN-JIT"**			GIVEN		Key Activities
	Project Manager	Ken Smith				WITH	2	weeks	= LAG Time before PACER Activity
BE SPECIFIC. "ASAP" is not a Deadline!	**GIVEN**	Project ID:	Example						
	Project Time Unit	weeks	*Options*	"Days," "Weeks" or "Months"		A	6	weeks	= PACER
	PROJECT START DATE:	1-Jan-21	*with*	5	Repetitions Desired	AND	3		= LEAD Time after PACER Activity
	Calendar Number =	44197			*See FN at the right	THEN	JITLOB Duration is		
							=	35	weeks
B. APART from CONCURRENT '*FAST TRACKING*,' SEQUENTIAL is the ALTERNATIVE							Complete	03-Sep-21	
TOTAL DURATION IF UNITS ARE COMPLETED *SEQUENTIALLY*		55	*weeks*	21-Jan-22			Calendar # =	44442	
Dur = Reps(Lag+Pacer+Lead)		***NET BENEFIT WITH JITLOB SCHEDULING***					Dur = Lag + Reps(Pacer) + Lead		
© 2020 Dr. Kenneth F. Smith, PMP kenfsmith@aol.com		ACCELERATION =	*20*	*weeks*	*Faster than Sequential Scheduling*		*36%*	*SCHEDULE IMPROVEMENT*	*Plus SAVINGS in INDIRECT COSTS!!!*
BUT if Higher Authorities Impose a DEADLINE		Reps = [Dur - (Lag+Lead)] / Pacer					NOTE: *Round Down if EIU is a decimal*		
by either a Date =	15-Jun-22	76	weeks	after Project Start Date		11.8	*End Item Units can be Produced*		
or a Numbered Duration =	50	weeks	after Project Start Date	17-Dec-21		7.5	*End Item Units can be Produced*		
"If you can keep your 'cool' while all around you are losing theirs, You just don't understand the situation!" KFS									

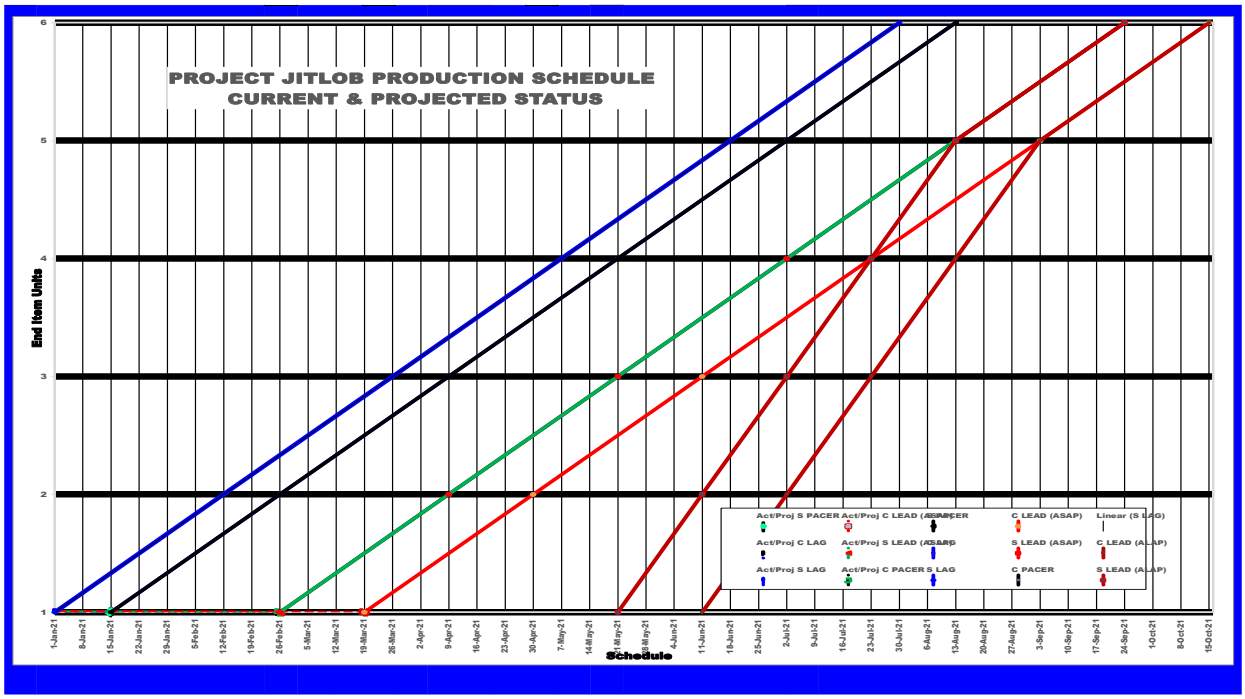
Given this data, the repetitive schedule of the project process for **Crucial milestones** on the **Cumulative Critical Path** is created for ***up to 430 repetitions***, as partially shown in **Figure 11.**

FIGURE 11

KEN-JIT REPITPLAN	NUMBERED DURATION FORMAT								PLAN YOUR WORK !		
C. END ITEM UNIT (OR BATCH) PRODUCTION, & DELIVERY SCHEDULE (*in TIME INCREMENTS*) of									Weeks		
END ITEM ITERATIONS:	1	2	3	4	5	6	7	8	9	10	11
KEY UNIT MILESTONES	Weeks		NOTE: If 'LAG' Starts are Erratic, In Row '2 Complete LAG' under the Iteration, Enter a number								
1 Start LAG (ALAP)	0	6	12	18	24	NA	NA	NA	NA	NA	NA
2 Complete LAG	2	8	14	20	26	NA	NA	NA	NA	NA	NA
3 S PACER	2	8	14	20	26	NA	NA	NA	NA	NA	NA
4 C PACER	8	14	20	26	32	NA	NA	NA	NA	NA	NA
5 S LEAD (ASAP)	8	14	20	26	32	NA	NA	NA	NA	NA	NA
6 C LEAD (ASAP)	11	17	23	29	35	NA	NA	NA	NA	NA	NA
7 *S LEAD (ALAP)*	20	23	26	29	32	NA	NA	NA	NA	NA	NA
8 *C LEAD (ALAP)*	23	26	29	32	35	NA	NA	NA	NA	NA	NA

As well as a ***compact*** **Cumulative Delivery Schedule 'Production Parallelogram'** for the **entire Project** shown in **Figure 12.**

FIGURE 12



Milestone Progress reporting is then summarized in the yellow cells of **Figure 13.**

FIGURE 13

	KEN-JIT REPORT	NUMBERED DURATION FORMAT						WORK YOUR PLAN !				
D. DATA ENTRY ACTUAL END ITEM IMPLEMENTATION PROGRESS REPORT [ENTER IN YELLOW CELLS. COMPARE CRUCIAL MIL												
	END ITEM ITERATIONS:	1	2	3	4	5	6	7	8	9	10	11
	KEY UNIT MILESTONES	weeks										
1	S LAG	1										
2	C LAG	4										
3	S PACER	5										
4	C PACER	11										
5	S LEAD	12										
6	C LEAD	15										
7	S LEAD (ALAP)	25	27	29	31	33	NA	NA	NA	NA	NA	NA
8	C LEAD (ALAP)	27	29	31	33	35	NA	NA	NA	NA	NA	NA
	END ITEM:	1	2	3	4	5	6	7	8	9	10	11

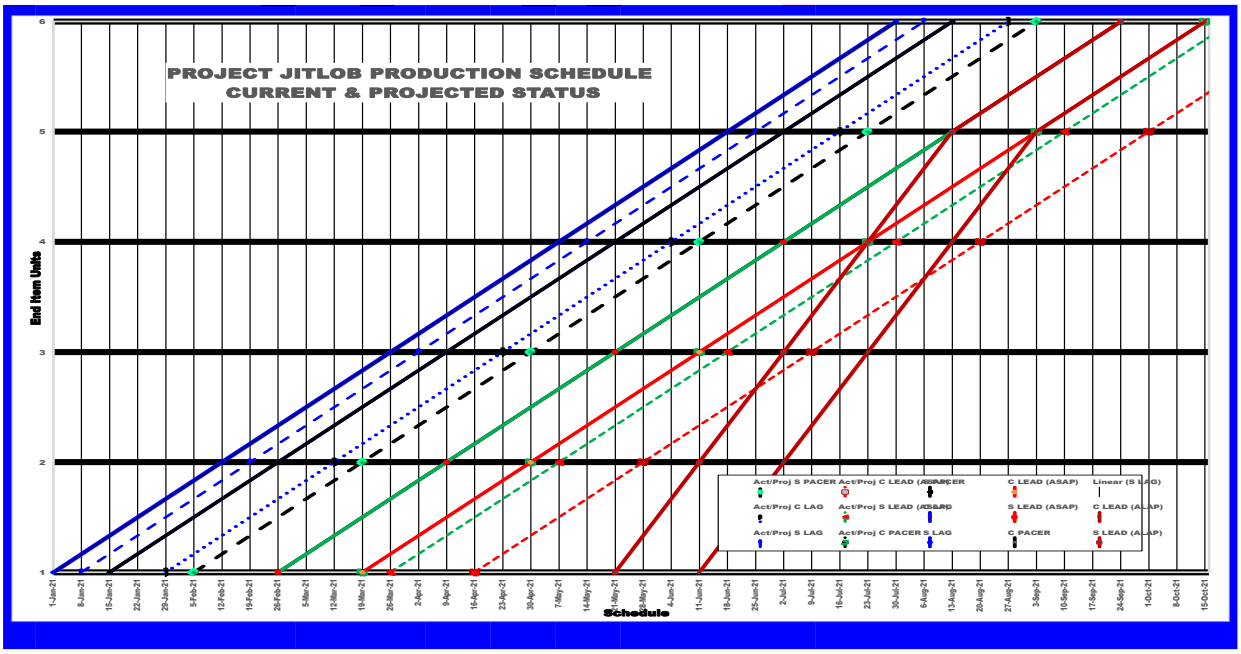
The summary status, actual updated variance & forecast is then shown in **Figure 14.**

FIGURE 14

	kenfsmith@aol.com	COPY of HOW'S IT GOING ?						Calendar Project Start Number =				44197
	RIAL & ERROR TIME CHECK FROM PROJECT START DATE =	15	weeks	=	16-Apr-21	=	44302					
	KEN-JIT PROGGRAPH	JITLOB END ITEM UNIT PROGRESS REPORT:- ACTUAL & PROJECTED TREND VS										
	I. LINE OF BALANCE FOR END ITEM UNIT (OR BATCH) KEY MILESTONES											
	S LAG	1-Jan-21	12-Feb-21	26-Mar-21	7-May-21	18-Jun-21	30-Jul-21	10-Sep-21	22-Oct-21	3-Dec-21	14-Jan-22	25-Feb-22	8-Apr-22
	C LAG	15-Jan-21	26-Feb-21	9-Apr-21	21-May-21	2-Jul-21	13-Aug-21	24-Sep-21	5-Nov-21	17-Dec-21	28-Jan-22	11-Mar-22	22-Apr-22
	S PACER	15-Jan-21	26-Feb-21	9-Apr-21	21-May-21	2-Jul-21	13-Aug-21	24-Sep-21	5-Nov-21	17-Dec-21	28-Jan-22	11-Mar-22	22-Apr-22
	C PACER	26-Feb-21	9-Apr-21	21-May-21	2-Jul-21	13-Aug-21	24-Sep-21	5-Nov-21	17-Dec-21	28-Jan-22	11-Mar-22	22-Apr-22	3-Jun-22
	S LEAD (ASAP)	26-Feb-21	9-Apr-21	21-May-21	2-Jul-21	13-Aug-21	24-Sep-21	5-Nov-21	17-Dec-21	28-Jan-22	11-Mar-22	22-Apr-22	3-Jun-22
	C LEAD (ASAP)	19-Mar-21	30-Apr-21	11-Jun-21	23-Jul-21	3-Sep-21	15-Oct-21	26-Nov-21	7-Jan-22	18-Feb-22	1-Apr-22	13-May-22	24-Jun-22
	S LEAD (ALAP)	21-May-21	11-Jun-21	2-Jul-21	23-Jul-21	13-Aug-21	24-Sep-21	5-Nov-21	17-Dec-21	28-Jan-22	11-Mar-22	22-Apr-22	3-Jun-22
	C LEAD (ALAP)	11-Jun-21	2-Jul-21	23-Jul-21	13-Aug-21	3-Sep-21	15-Oct-21	26-Nov-21	7-Jan-22	18-Feb-22	1-Apr-22	13-May-22	24-Jun-22
	Act/Proj S LAG	8-Jan-21	19-Feb-21	2-Apr-21	14-May-21	25-Jun-21	6-Aug-21	17-Sep-21	29-Oct-21	10-Dec-21	21-Jan-22	4-Mar-22	15-Apr-22
	Act/Proj C LAG	29-Jan-21	12-Mar-21	23-Apr-21	4-Jun-21	16-Jul-21	27-Aug-21	8-Oct-21	19-Nov-21	31-Dec-21	11-Feb-22	25-Mar-22	6-May-22
	Act/Proj S PACER	5-Feb-21	19-Mar-21	30-Apr-21	11-Jun-21	23-Jul-21	3-Sep-21	15-Oct-21	26-Nov-21	7-Jan-22	18-Feb-22	1-Apr-22	13-May-22
	Act/Proj C PACER	19-Mar-21	30-Apr-21	11-Jun-21	23-Jul-21	3-Sep-21	15-Oct-21	26-Nov-21	7-Jan-22	18-Feb-22	1-Apr-22	13-May-22	24-Jun-22
	ct/Proj S LEAD (ASAP)	26-Mar-21	7-May-21	18-Jun-21	30-Jul-21	10-Sep-21	22-Oct-21	3-Dec-21	14-Jan-22	25-Feb-22	8-Apr-22	20-May-22	1-Jul-22
	ct/Proj C LEAD (ASAP)	16-Apr-21	28-May-21	9-Jul-21	20-Aug-21	1-Oct-21	12-Nov-21	24-Dec-21	4-Feb-22	18-Mar-22	29-Apr-22	10-Jun-22	22-Jul-22
	END ITEM:	1	2	3	4	5	6	7	8	9	10	11	12

And the **Production Parallelogram** is updated with **Actual** and **Revised (Best Case) Forecast** data for management information & necessary mitigation action, as depicted in **Figure 15**.

FIGURE 15



Furthermore, **if the situation is determined to be a** '**New Norm,**' the template can be updated with the **actual Lag, Pacer & Lead data** for the previous **EIU,** and rerun for the remaining iterations, as shown in **Figure 16.**

FIGURE 16

JUST-IN-TIME/LINE-OF-BALANCE (JITLOB): PLANNING, SCHEDULING & MONITORING
KEY PERFORMANCE INDICATORS (KPIs) of REPETITIVE-TYPE PROJECTS

A. FEASIBILITY ASSESSMENT PLANNING:
ENTER DATA IN YELLOW CELLS

"KEN-JIT"

	Project Manager	Ken Smith			WITH	3 weeks	= LAG Time before PACER Activity
BE SPECIFIC. "ASAP" is not a Deadline!	GIVEN	Project ID:	Example					
	Project Time Unit	weeks	Options	"Days," "Weeks" or "Months" *See Feature 7 at the right	A	6 weeks	= PACER
	PROJECT START DATE:	16-Apr-21	with	4	Repetitions Desired	AND	3	= LEAD Time after PACER Activity
	Calendar Number =	44302			*See FN at the right	THEN	JITLOB Duration is = 30 weeks	
							Complete	12-Nov-21
							Calendar # =	44512
							Dur = Lag + Reps(Pacer) + Lead	

B. APART from CONCURRENT '*FAST TRACKING*,' SEQUENTIAL is the ALTERNATIVE

TOTAL DURATION IF UNITS ARE COMPLETED *SEQUENTIALLY*	48	*weeks*	18-Mar-22
Dur = Reps(Lag+Pacer+Lead)	***NET BENEFIT WITH JITLOB SCHEDULING***		

© 2020 Dr. Kenneth F. Smith, PMP
kenfsmith@aol.com

ACCELERATION = *18* *weeks*
Faster than Sequential Scheduling

38% ***SCHEDULE IMPROVEMENT***
Plus SAVINGS in INDIRECT COSTS!!!

BUT If Higher Authorities Impose a DEADLINE	Reps = [Dur - (Lag+Lead)] / Pacer				NOTE: *Round Down if EIU is a decimal*	
by either a Date =	15-Jun-22	61	weeks	after Project Start Date	9.1	*End Item Units can be Produced*
or a Numbered Duration =	50	weeks	after Project Start Date	1-Apr-22	7.3	*End Item Units can be Produced*

"If you can keep your 'cool' while all around you are losing theirs, You just don't understand the situation!" KFS

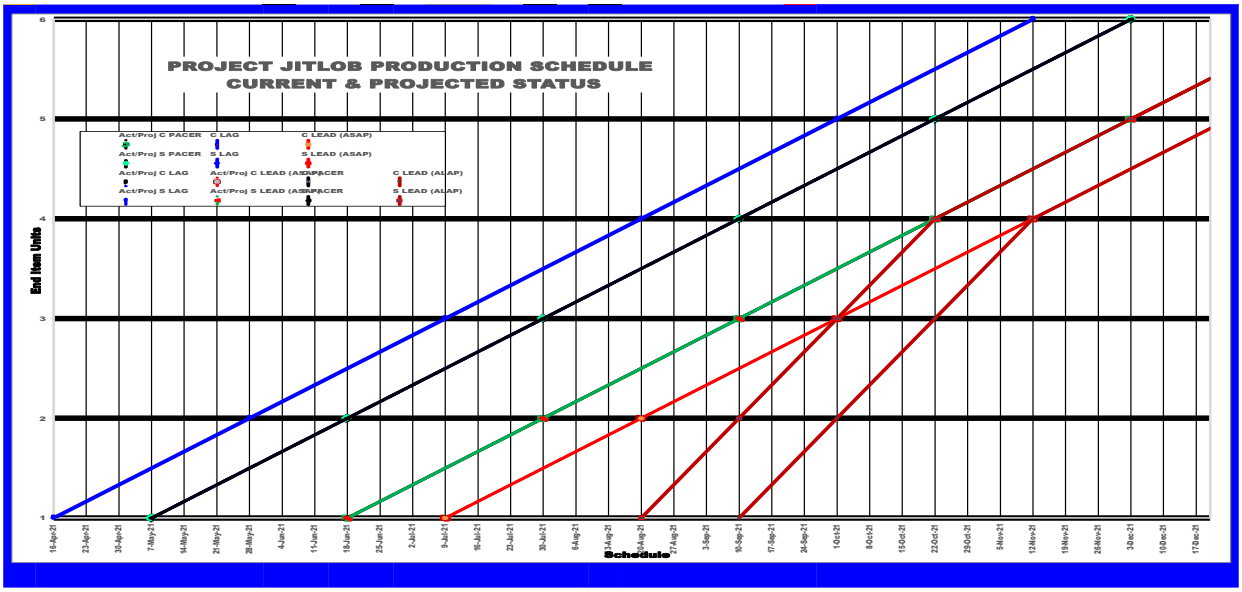
Producing a revised schedule:

FIGURE 17

	KEN-JIT REPSCHED	DATE FORMAT	WORK YOUR PLAN !					
F. END ITEM UNIT (OR BATCH) PRODUCTION, & DELIVERY SCHEDULE (*in TIME INCREMENTS*) of								
	END ITEM ITERATIONS:	1	2	3	4	5	6	7	8
	KEY UNIT MILESTONES	weeks							
1	S LAG	16-Apr-21	28-May-21	9-Jul-21	20-Aug-21	1-Oct-21	12-Nov-21	24-Dec-21	4-Feb-22
2	C LAG	7-May-21	18-Jun-21	30-Jul-21	10-Sep-21	22-Oct-21	3-Dec-21	14-Jan-22	25-Feb-22
3	S PACER	7-May-21	18-Jun-21	30-Jul-21	10-Sep-21	22-Oct-21	3-Dec-21	14-Jan-22	25-Feb-22
4	C PACER	18-Jun-21	30-Jul-21	10-Sep-21	22-Oct-21	3-Dec-21	14-Jan-22	25-Feb-22	8-Apr-22
5	S LEAD (ASAP)	18-Jun-21	30-Jul-21	10-Sep-21	22-Oct-21	3-Dec-21	14-Jan-22	25-Feb-22	8-Apr-22
6	C LEAD (ASAP)	9-Jul-21	20-Aug-21	1-Oct-21	12-Nov-21	24-Dec-21	4-Feb-22	18-Mar-22	29-Apr-22
7	S LEAD (ALAP)	20-Aug-21	10-Sep-21	1-Oct-21	22-Oct-21	3-Dec-21	14-Jan-22	25-Feb-22	8-Apr-22
8	C LEAD (ALAP)	10-Sep-21	1-Oct-21	22-Oct-21	12-Nov-21	24-Dec-21	4-Feb-22	18-Mar-22	29-Apr-22
	END ITEM:	1	2	3	4	5	6	7	8

And a new **Production Parallelogram:**

FIGURE 18



So, **if there's a repetitive-type project or process on your work horizon**, consider going **'*back to the future*'** with **JITLOB's** contemporary **'Cumulative Critical Path,'** and my just-in-time template: **"KENJIT."**[24]

[24] **KENJIT is now available for free** from kenfsmith@aol.com – *together with over 100 other Project Management templates* – on proof of purchase of **Project Management PRAXIS** from Amazon.

About the Author

Dr. Kenneth Smith

Honolulu, Hawaii

Dr. Kenneth F. Smith was a project management consultant for ADB, the World Bank, and USAID for decades. He earned his DPA (Doctor of Public Administration) from the George Mason University (GMU) in Virginia and his MS from Massachusetts Institute of Technology (MIT Systems Analysis Fellow, Center for Advanced Engineering Study). A long-time member of the Project Management Institute (PMI) and IPMA-USA, Dr. Smith is a Certified Project Management Professional (PMP®) and a member of the PMI®-Honolulu Chapter.

Ken's book -- **Project Management PRAXIS** (available from Amazon) -- includes many other innovative project management tools & techniques; and describes a "**Toolkit**" of related templates available directly from him at kenfsmith@aol.com.