Using Little's Law to Understand Flow and Design of TOC Solutions

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Ryoma Shiratsuchi has been a TOC Consultant since 2007, as a manager of Juntos Co. Ltd.

He teaches Operations Management and Project Management as a lecturer at Education & Research Center of Manufacturing, Kyushu University.

His involvement with TOC started in 2004 with implementing CCPM into Bridge Design Department in Juntos. And after its successful implementation, he was sent to the sister company (Construction) and led CCPM implementation project as an internal consultant.

He co-translated "TOC Insights" into Japanese.

Since 2007, he has received intensive instruction from Oded Cohen, the International Director for Goldratt Schools and since 2008 he has been a Goldratt Schools faculty member.

Now he is providing TOC trainings and implementation support, especially in the areas of production and project management.

Objective

- To share my learning about:
  - The effective preparation for implementations

- Participants will get the following:
  - Some references of the Current Reality Study (CRS) for the various environments – MTO, MTA and Projects

Agenda

- Background
- Where to use Little's Law
- Case 01 – Project (ETO)
- Case 02 – MTA
- Case 03 – MTO -> MTIA

Introduction

- One of the major headaches during the implementation is rework. It leads to:
  - Longer implementation period
  - A sense of futility of the implementation team
  - Distrust between the client and the consultant

- Some reworks are caused by the lack of a good preparation. Speculated causes are:
  - Misunderstanding of the current reality
  - Misunderstanding of the solution

Current Reality Study – CRS

The reality of the system is influenced by the following three major factors:

Major Factors	Tools
Modes of Supply	Deployment Chart
Production Flow	V-A-T-I
Capacity Profile	Resource Categories (Bottlenecks, CCR and Non-CCR)

Knowing the Production lead time (PLT) is important for the understanding of both the physical process and the managerial processes.

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Where to use Little's Law

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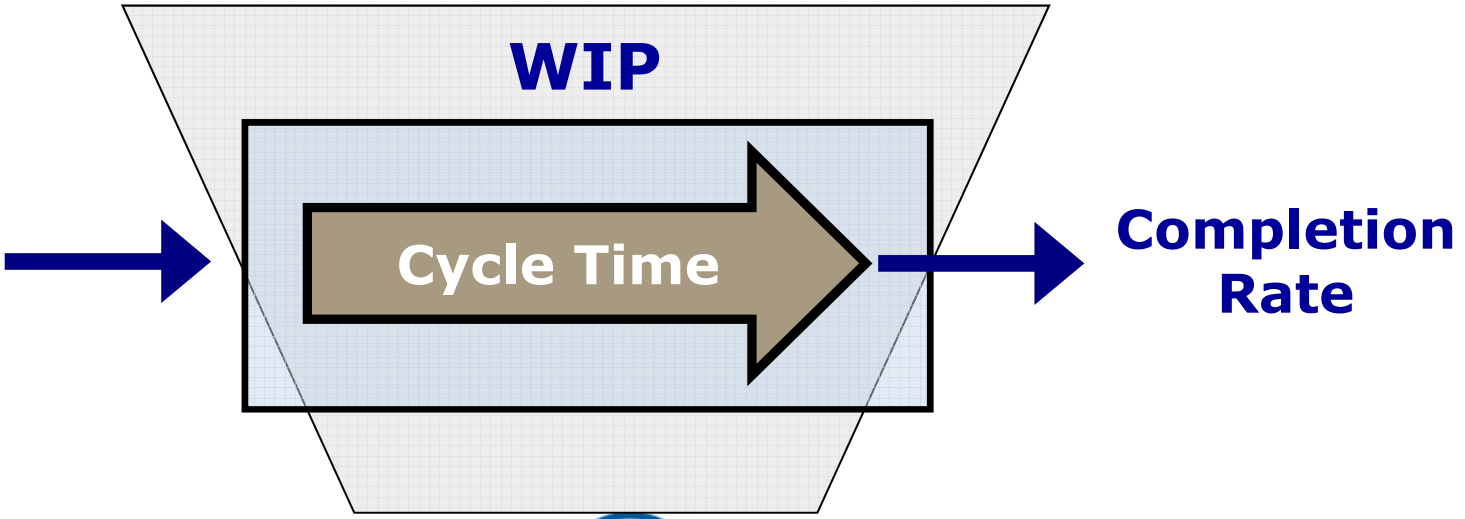
Little's Law

$$WIP = Cycle\ Time \times Completion\ Rate$$

$$Cycle\ Time = WIP / Completion\ Rate$$



Estimating PLT by Little's Law

The formula:

PLT = WIP / Completion Rate

- The units of PLT is time. WIP is in money. Completion rate has to be in money/time unit. Let's take time unit as day.
  - PLT [unit] = money / (money/days) = [days]
- Therefore, the completion rate has to be measured in terms of money per day. We can make the formula as below:
  - PLT [days]= WIP/Completion Rate (daily)
- Note: when we take the figure of **WIP in RM value**, we have to use the figure of **Sales in RM value** as the completion rate.

Little's Law is used for:

- Better understanding of the current flow
  - Production lead time (PLT)
  - The way of planning
  - Magnitude of Bad Multitasking

- Designing a relevant solution
  - Setting Production Buffers in MTO
  - Determining Reliable Replenishment Time (RRT) for setting Stock Buffers in MTA
  - Setting Target WIP & Cycle time in Projects

Some Benefits by Using Little's Law

When communicating with the client's team, we can deliver the following:

- **Clear and correct message for improving flow**
  - If we want to increase Throughput/Productivity, then we must have much shorter cycle time than reduction in WIP.
  - Implementing Buffer Management (BM) is justified.

- **Concrete image of the suggested solution with a quantitative perspective**

Example

	Original	After Choking the Release	Then
WIP	3000	1000	400
PLT (days)	14	5	3
TP	214	200	133

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Case 01 – Project (ETO)

- The company produces laboratory glassware and chemical processing equipment.
- They implemented SDBR in Production and thereafter decided to implement CCPM in Engineering.
- ETO projects – Design, Manufacturing, Assembly, Packing and Erection & Commissioning.
- Average completion rate is 13 projects/month.
- Current WIP is around 32 projects in total.
- Every project is spending half its time in manufacturing, it is not asking engineering capacity during that time.

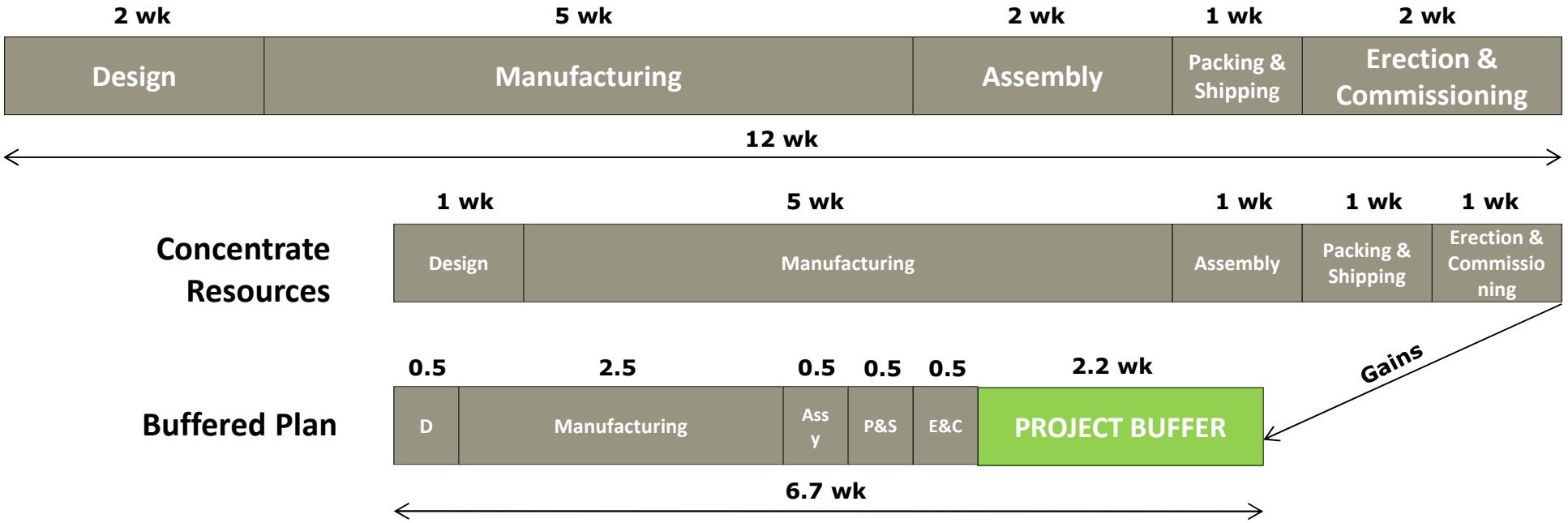
Setting Target WIP & Cycle Time

How to calculate the active WIP when the projects contain the phase which gets out of the system?

- Current active WIP (in Engineering) is therefore around 16 projects.
- Assuming that every engineer works on single task/project in a given period of time, allowable maximum WIP should be around 8 projects.
- WIP reduction required: 50% (from 16 to 8 projects in active WIP in Engineering)
- Cycle time reduction possible: 60% with resource concentration (FK is a prerequisite)
- Completion rate increase possible: 0.5/0.4=1.25 or 25% improvement
  With 25% completion rate increase, target of 16 projects/month

Setting Target WIP & Cycle Time

The Target Cycle time should be calculated based on the Target WIP which concentrates resources.



If we reduce WIP by 50% and want to increase Completion rate by 25%, then we must reduce Cycle time by 60% in Engineering (Design, Assembly and E&C)

Results

During the two months of implementation, the following results were achieved:

- Increased Completion rate of projects
  - From 13 to 16 projects/month (23% increase)
- Reduced overtime
  - Engineers' overtime reduced by 35%
  - Mostly achieved “8 hours a day, 5 workdays”

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Case 02 – MTA

- The company produces parts for automotive and agricultural machines. It is an "I" plant.
- MTO : MTS = 10% : 90%
- 260 working days per year.
- The total sales of in-house products (MTO + MTS) is $10.8m.
- TVC = 25%
- Average WIP inventory is $40K.
- FG stock of in-house products is $250K – in terms of RM value

Assessment of FG Stock – DIOH

How to calculate "Days Inventory" (DIOH and PLT) when the system is in a mixed (MTO + MTS) environment?

- For the store – It is possible to know how much of the FG stock is for the SKUs that are sold from stock. We can assume that the share of the sales from stock is 90%.
- So for the FG store we can assume that 90% of the FG stock is for the SKUs that are sold from stock. Hence the value is 250K x 0.9 = 225K
- Sales of stock of in-house products (MTS) = 10.8m (total sales of in-house products) x 0.9 (for sales from stock – non MTO) x 0.25 (TVC) = 2.4m per year.
- "Daily Sales": 2.4m/260 = around 9K
  Therefore, we can calculate the DIOH (FG) as: 225K/9K = 25 days

Assessment of WIP Level – PLT

The calculation of "Daily Sales" is different for assessing DIOH of stores and for assessing WIP and PLT.

- Regarding the WIP – We do not really know how much of the WIP is for MTO and how much is for MTS. Therefore, it is simpler to assume that the mix is about the same.
- So the PLT can be calculated based on the day of sales of the in-house products.
- Sales of the in-house products (MTO and MTS) = 10.8m x 0.25 (TVC) = 2.7m per year.
- "Daily Sales": 2.7m/260 = around 10K
  Therefore, we can calculate the PLT (days) as: 40K/10K = 4 days

Results

During the four months of implementation, the following results were achieved:

- Increased Availability for MTA SKUs (> 2000 items)
  - From 92-93% to 97-98%
- Same FG stock level (DIOH)
- Increased Sales by 5%
- Significant reduction in overtime

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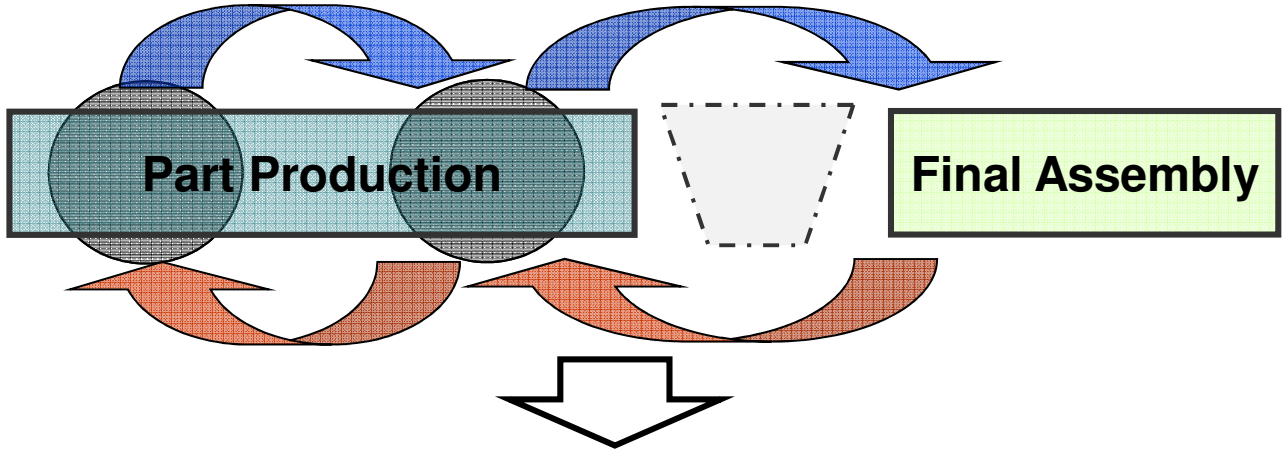
Case 03 – MTO -> MTIA

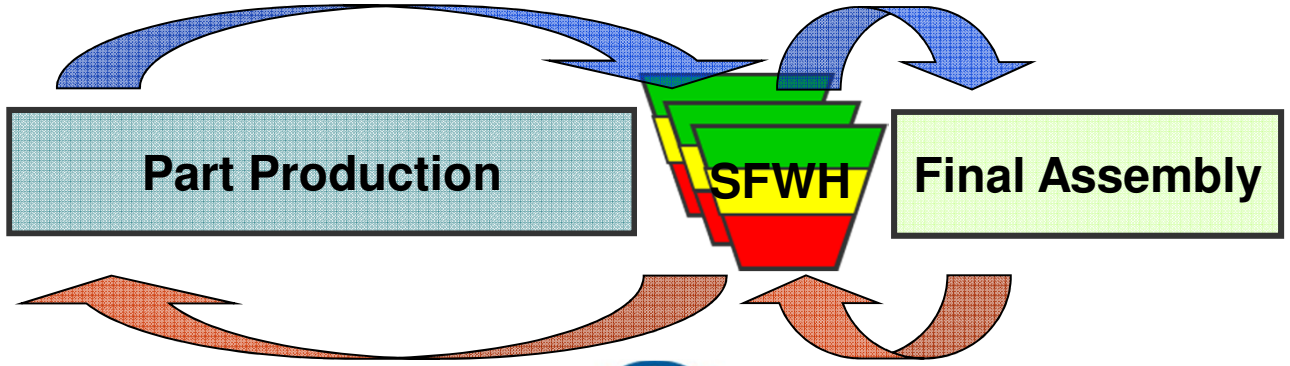
- The company produces marine engines as well as the spare parts of them. It is a “T” plant.
- Even though they produce and supply to a distribution channel, they operate as if they were MTO.
- The final assembly determines the shipping schedule as well as the schedule for part production (machining) and purchasing.
- In order to reduce inventory, every process is tied up based on the assembly schedule. But it creates the significant capacity problems on the machining shop.
- Currently they don’t have the store in front of assembly formally in the system. So the Semi-Finished goods warehouse (SFWH) is necessary for the MTIA to work and ensure availability of the produced parts.

Suggested Solution – MTIA

"Individual PULL" – Assembly is DRUM



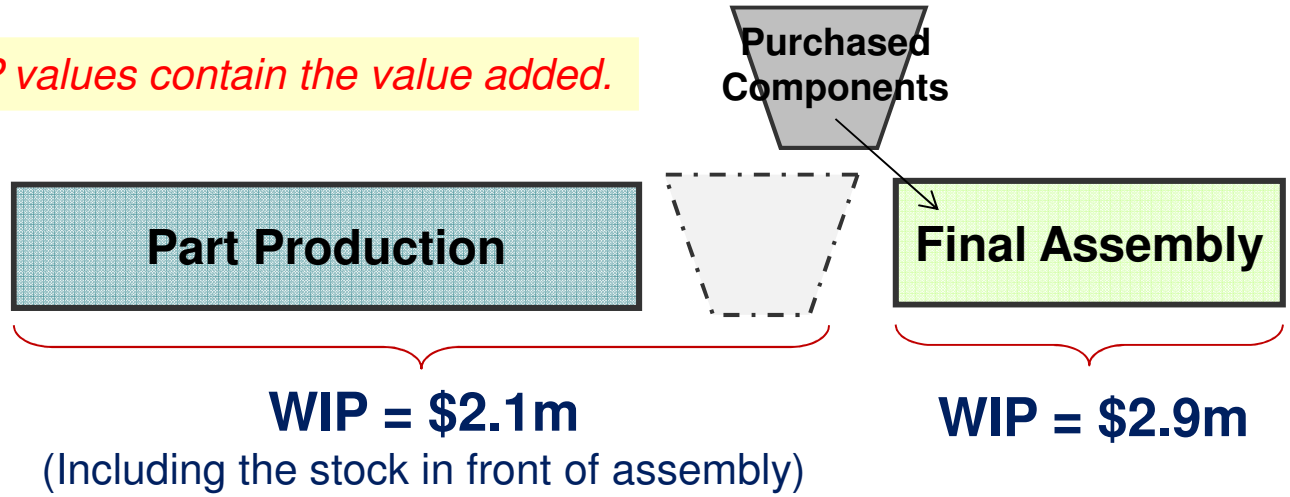
"Integrated PULL" – Consumption from SFWH is DRUM



Assessment of WIP Level – PLT

How do we calculate the WIP level when the stock records contain the value added?

The WIP values contain the value added.



- COGS: $225m
- 250 working days per year
- TVC: 72%
- % of the parts produced in house: 20% - in value

Issue:

As the WIP values contain the value added, we can't use the value of Sales in TVC terms.

Assessment of WIP Level – PLT

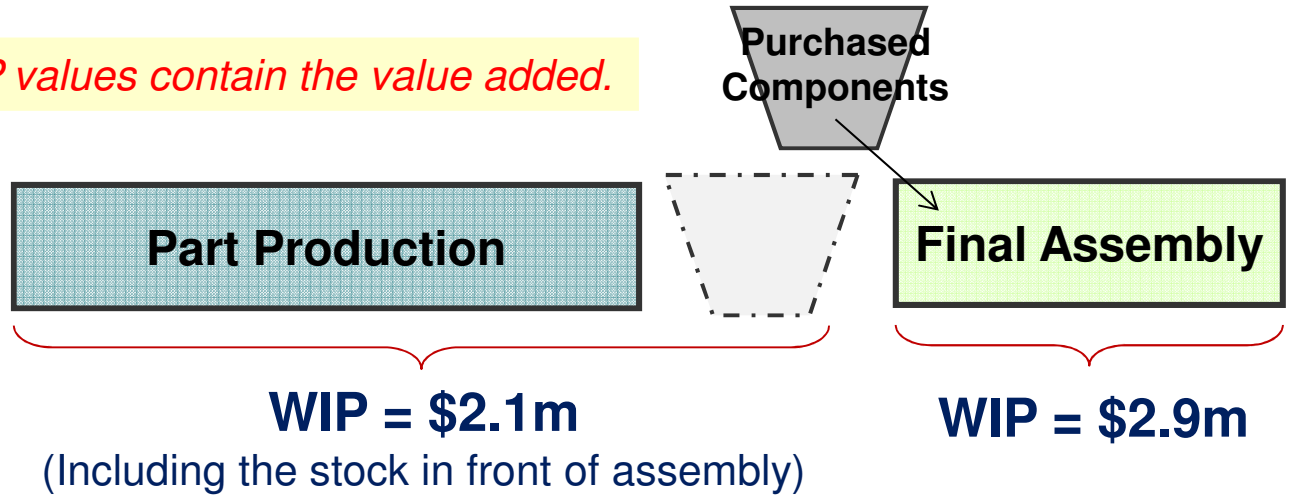
How do we calculate the WIP level when the stock records contain the value added?

- The TOC recommendation is to calculate the number of days in stock based on TVC.
- However, it may be difficult – at least at the outset of the pilot, to get the TVC of parts that are produced in house.
- For companies that use conventional costing, we can use the formula for calculating the inventory by using:
  - Cost of Goods Sold (COGS)
  - The value of inventory which includes the value added
- COGS/ working days = "Daily Sales"
  Average WIP/ "Daily Sales" = Days Inventory

Assessment of WIP Level – PLT

The calculation can be done by using COGS and the value of inventory which includes the value added.

The WIP values contain the value added.



For Part production –

"Daily Sales": 225m*0.2/250 = 0.18m

WIP level: 2.1m/0.18m = 12 days

For Assembly -

"Daily Sales": 225m/250 = 0.9m

WIP level: 2.9m/0.9m = 3 days