2019 TOCICO International Conference THE PRODUCTIVITY JOURNEY

OF CONSTR

Extreme Drum-Buffer-Rope and Extreme Buffer Management

ONAL CERTIFICATIO

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Agenda

A quick review of T-DBR vs S-DBR

Two Extreme DBR Examples Our Approach to Improving Flow using X-DBR



The Evolution of Drum-Buffer-Rope (DBR)

Traditional DBR

- Developed in mid 80s as a relatively simple, yet effective, production planning methodology
- Focuses on detailed finite capacity scheduling of the capacity constrained resource (CCR)
- Sometimes up to 3 buffers CCR Buffer, Shipping Buffer & Assembly Buffer
- Creates a sequence that exploits the CCR sequence often changes after the Drum to follow due date



Traditional DBR

- The Drum, or Control Point, defines the system output and sets the pace for a specific flow stream
- The Buffer is the right amount of work released to the drum to ensure its continued operation and set its priorities
- The Rope controls material release





The Evolution of DBR

Simplified DBR

- Developed in early 2000s to extend the benefits of T-DBR and make it even simpler to implement
- Focuses on prioritizing to due date throughout the plant
- Only 1 buffer the shipping buffer
- The sequence at the CCR is not planned although the sensible decision of which order to do next depends on the state of the buffers
- Delivery dates are promised based on the planned load on the CCR



Simplified DBR

- Orders are scheduled according to due date dates are committed according to the CCR Planned Load
- The Buffer ensures every order is given enough time to flow through the shop floor
- The Rope ensures that only orders to be delivered in the shipping buffer time are released to the floor



The Basic Assumptions behind S-DBR*

The market is always a constraint

The CCR is generally insensitive to small changes in processing sequence

> Such changes don't usually have much impact on the overall performance of the system



*Schragenheim & Dettmer, Manufacturing at Warp Speed, St. Lucie Press, 2001

The Basic Assumptions behind S-DBR

The market is always a constraint

The CCR is generally insensitive to small changes in processing sequence

If short lead times are a competitive advantage and the sales backlog is increasing (and therefore lead times are increasing) then we should consider the constraint to be internal If there is at least a 40% capacity utilization difference between sequencing the orders for the Drum and not sequencing, then we should pay as much attention to sequencing as possible



Extreme DBR is a subset of T-DBR

S-DBR

T-DBR

X-DBR

What makes it Extreme is the massive degree of dependence between orders and / or the number of variables to consider when scheduling



Two Extreme Examples

Large dependence between orders

• Heat Treating

Large number of order variables to sequence

Aluminum
Extrusion



Heat Treating

The constraint is internal – running 7x24

Order sequence matters

Material availability is a not critical issue

Flow is an I plant

Scheduling to customer demand was already done well

Keys to exploitation are sequencing orders to maximize machine utilization, due date performance, load factor and basket rotation





Basic Profiles of durations needed to be sequenced

- 1. Long Furnace / Short Quench
- 2. Equal Durations
- 3. Short Furnace / Long Quench



Heat Treating

 The challenge is to fit the 'Tetris' Blocks together to minimize the time where either the Furnace or the Quench is Empty



Scheduling Considerations











Extreme DBR (X-DBR) requires Extreme Buffer Management (X-BM)



Buffer Management enhanced to measure Hours Lost



Hours Lost is the difference between when an order should finish Quench and when it actually finishes Quench



Hours Lost Pareto

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	2019-03-01 06:59	Drum Performan	Operator Unavai		Livonia	Day Shift	Q6	CMS	4	Closed	SERIES 9	Cylinder Liner	76761_4	Yes	0.3	0.50	0.!
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4	2019-03-02 19:16	Drum Performan	Operator Unavai		Livonia	Night Shift	03	CMS	3	Closed	3235A23	Diffrase	77139 0	Yes	3.6	0.21	-0.1

Drum Performance Issues Hours Lost

By Work Center By Issue Issues By Work Center Work Center Delays By Day



The operator is prompted to record the reason for the Hours Lost for any loss greater than 15 minutes

YTD 2019, the top Flow Issues causing the most Hours Lost were

- No / Incomplete preheat
- Operator Unavailable
- Incorrect Ramp Up

The actual work order and part # is known for each issue

Displaving 3756 out of 3756 records retrie



Since 2016





Two Extreme Examples

Large dependence between orders

• Heat Treating

Large number of order variables to sequence

Aluminum
Extrusion



Aluminum Extrusion

The constraint is internal – running 7x24

Order sequence matters

Material availability and utilization is a critical issue

Flow is a V plant

Scheduling to customer demand was already done well but very manual

Keys to exploitation are sequencing orders to maximize material utilization, machine utilization and due date performance



Aluminum Extrusion





Sequencing Challenges



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Execution Challenges

Strongly held belief - Maximizing Kg / Hour is the "only way to make money"

Dies Fail – a lot

 Of the 12,000 work orders scheduled Jan to May 2019, 1,500 were not run due to Die Failure (12.5%) representing 20% of the scheduled hours

Operators want to run...

- Orders that will run faster
- Orders with Dies that will not fail
- In other words, they don't want to run the schedule



Variability and Dependency

Sources of Variability

- Die speed
- Die correction time
- Die warming
- Die performance
- # of Die copies available
- # of Die cavities
- Alloy type
- Billet length and availability
- Saw speed (# of cuts)
- Press performance
- Operator experience / training / absenteeism
- Customer order changes

Sources of Increased Dependency

- Buying billets to length
- Buying billets to order / forecast
- Loading billet oven with 10 to 20 billets
- Limited quantity of die copies
- Scheduling dies across presses
- Limited table size
- Make to order strategy



The TOC Approach to Flow

Focus on Reducing Variability everywhere Focus on Reducing Dependency first, then Variability



Cost Focus

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Flow Focus



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VS.

Breaking Dependence

• Typically three ways – buffer with stock, time and / or capacity

Source of Dependency	Stock	Time	Capacity	Comment
Buying billets to length				Capital intensive - No short term solution
Buying billets to order / forecast	Х			Billet Stock Buffers
Loading billet oven with 10 to 20 billets				Capital intensive - No short term solution
Limited quantity of die copies			х	Slowly increasing copies
Scheduling dies across presses			х	Slowly increasing copies
Limited table size				Capital intensive - No short term solution
Make to order strategy				No space - no short term solution

 The solution focused on ensuring VISIBILITY of the Dependence to MANAGE it vs Break it





Sequencing Visibility

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	+1/4 +22000_0_H11 D. 12 S.	E519668	2019/09/29 2019/07/04 MILLEINSH	140 1400 00.42 0.06 6063 5 ES	1996 DUVI, DOUD, RUI, RVI, DAVI, SZ 10, LR190327, C114, DP190525	DL11W, DDL Z	PR6, 035, C, 100+10 Comp%000	2019/06/29 01:19 Clear	Hig. DC00100113521025	43.37 3810
	415 40000 (A DU A DU A DU A D	E\$19667	2010/07/20 2010/07/04 MILL FINSH	*10 2000 55%8 0.12 6063 5 ES	Press Down, Down, Hu I, Hu I, Dilut, Sz. IZ, LH ISON/2014665 6, DP190625	04 1 W/ 80C 0	Pres. 0-38, C00+10 Comp/2000	2019-06-27 01:25 Cites	Aug. DC0010/112852 125 A /	4343 3810
	414 400010_04_011 1. 12 SL B	EH15124	2019-09-29 2019-07-04 MILLEINSH	040 1000 00.00 0.19 6063 5 EH	10124 DCI25, DCI26, DCI20, HC20, HC2, DCI2, DCI20, DCI26,	DL IVWU, DDL /	Phis, Cob, C, Hor+10 Comp%041, SHI	- 2019-06-29 01:37 Clear	Hig. DC025 DW13 / 52 12 5 X / DC026 DW12 5 52 10 x 5	4350 180
	14 40001/_00_411 0. 12 A. A	EHUDING Council	2010/07/20 2010/07/04 1651	400 1900 UR.14 0.18 6063 5 EH	00000 DOWN, DOWN, POLL DWD, 22 10, DR 10062628 09, DP100620	01,000,000,0	Phil. Cab. C. 10+10 Comp. 000	2010/07/2010/06 Clear	http://bc.tototototi/1352/1025	44/14 240
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Buffer Management enhanced to measure Scheduled Difference

🗋 Flow Issue Manager - What to Fix																	
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Alert Time	Work Order	Shift Na	Issue Type	Issue	Note	Work Center	User	Step	Scheduled Hours	Completed Scheduled Hours	Step Status	FG Item	Red Order	Hours Ready	Hours Lost	Product Stream	1
Custom: 🍸	Contains: 🍸	Con 🍸	Equals: 🛛 🍸	Contains: 🛛 🏹	Contains: 🛛 🍸	Contains: 🍸	C 🍸	G 🍸	GreaterThan: 🍸	GreaterThan: 🍸	Equals: 🍸	Con 🍸	No f 🕅	' Gr 🍸	Gr 🍸	Contains:	γı
2019-05-16 07:29	458176_2_B11	1	Drum Performance	Die Failure	This order was m	6	sado	1	8.25	2.5	Closed	19166-0	Yes	9.7	0.00	Brampton	
2019-05-09 12:57	458176_1_A11	1	Drum Performance	LC Late / Sch Re		6	sado	1	8.2	6.04	Closed	19166-0	No	10.2	0.00	Brampton	
2019-05-12 07:56	458176_3_B11	1	Drum Performance		Only 1 copy provi	6	press6	1	8.13	7.54	Closed	19166-0	Yes	21.0	0.00	Brampton	
2019-05-14 20:00	458176_2_A11	2	Drum Performance			6		1	7.7	3.57	Closed	19166-0	Yes	7,202.6	0.00	Brampton	
2019-05-17 17:06	458176_2_A11	1	Drum Performance			6	sado	1	7.18	4.74	Closed	19166-0	Yes	7,202.6	0.00	Brampton	
2019-05-05 20:00	458176_4_A11	2	Drum Performance			6		1	7.15	6.71	Closed	19166-0	No	21.7	0.00	Brampton	
2019-05-07 20:00	458176_4_B11	2	Drum Performance			6		1	6.94	6.75	Closed	19166-0	No	20.2	0.00	Brampton	
2019-05-24 17:48	458318_2_A11	1	Drum Performance	Die Failure		6	sado	1	5	3.85	Closed	17738-0	No	7.5	0.00	Brampton	
2019-05-30 23:27	459028_1_A11	2	Drum Performance	Die Failure		6	sado	1	5	1.04	Closed	17738-0	No	26.5	0.00	Brampton	
2019-05-21 19:36	458271 1 A11	2	Drum Performance	Die Failure	Conv 93 94 provid	6	nress6	1	4.9	0.4	Closed	R11254	No	22.8	0.00	Brampton	
By Work Center By Issues By Work Center Delays By Day Drum Performance Issues Hours Lost Scheduled Difference												-					
250 200.			Flow Dela	Completed Hours	700 600 500 400		Sche	duled [Differe	nce							

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100

Die Failure

Planned

Ran Slower than Ran Unscheduled Did Not Attempt

Orders

A new measure of Scheduled Difference was developed to track the difference between Scheduled Hours and Completed Hours

50% of the orders needed a Flow Issue

From March to May 2019, the top Flow Issues consuming the most hours are

- Die Failure
- Ran Slower then Planned
- Ran Unscheduled orders

For the top two issues, the problem Dies are known



laying 3088 out of 3088 records retrie

Die Shop 2

Outsource

Die Shop 1

Die Shop 6

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No Die/Ring

Order less

Downtime

Net kg over

tolerance

Our Process to Improve Flow using X-DBR

Understand the sources of Variability – from suppliers, customers and in the plant

Identify the current actions the company is taking to increase Dependence

Identify the best place(s) in the flow to schedule – the control points

• Build the capability to sequence the orders to Exploit the Drum and create the rules for Subordination

Identify the best places in the flow to Break Dependence (with Time, Stock or Capacity) – or at least how to better manage it (with Visibility)

Establish the mechanism to identify and record meaningful Flow Issues to prioritize the Variability reduction initiatives



From our Experience

The more Extreme the sequencing requirements, the more Extreme the Buffer Management process (Flow Issue Reporting)

Awareness / Visibility of the Dependence can go a long way to helping with Flow improvement



2019 TOCICO International Conference

Presenter Bios

Duncan Patrick is Executive VP with CMS Montera (duncan.patrick@cmsmontera.com)

- •Prior to CMS, Duncan was a member of the senior leadership team of an industrial distributor, consulting manager at Ernst & Young, and Landman with Husky Oil
- Duncan is a Certified Management Consultant registered in Ontario
- Duncan holds an MBA degree from the Richard Ivey School of Business, Western University and a Bachelor of Commerce degree (with distinction) from The University of Calgary
- •Duncan is certified by the TOCICO in all aspects of TOC

Jack Warchalowski is the President of CMS Montera (jack.warchalowski@cmsmontera.com)

- Prior to CMS, Jack was the head of operations for the High Tech manufacturer, Ernst & Young management consultant, and a project engineer with Babcock & Wilcox
- •Jack is a Certified Management Consultant and a Professional Engineer registered in Ontario
- •Jack holds an MBA degree from the Wilfrid Laurier University and a Bachelor of Applied Science in Mechanical Engineering from the University of Waterloo in Waterloo, Ontario
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CMS Montera Inc.

- •CMS provides consulting and software to help clients grow by solving problems in Operations and the Supply Chain
- •CMS RoadRunner software offers greater visibility and synchronization to manufacturers, distributers and engineering companies



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