



2015 TOCICO International Conference – Cape Town, South Africa

# TOC to boost aeronautical manufacturing performance



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TOCICO 2015 International Conference  
Cape Town, South Africa

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## Abstract

# TOC to boost aeronautical manufacturing performance

Philip Marris

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Several recent cases of implementations of the Theory Of constraints in the aeronautical industry will be presented.

In all cases the performance of the plants were very rapidly and significantly improved: increase of 30% in Throughput and productivity in one month, reductions of >60% in WIP and significant increases in delivery due date performances.

To easily reduce Work In Progress the “2 for 1” rule was developed: a new work order could only be launched once 2 work orders have been completed. This facilitated the transition to a Drum-Buffer-Rope flow control mechanism.

SAP was often being used and hence had to be integrated into the solution.

In some cases the extraordinary speed and amplitude of the results were due to an error in the identification of the constraint of the factory.

# Content

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- Case B: Large Aeronautical Ball Bearings
- Case C: Small Aeronautical Ball Bearings
- Conclusion
  
- Annexes

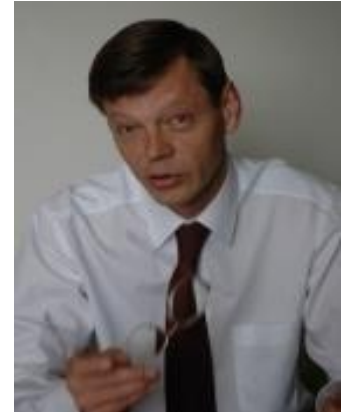
# Introduction

# Philip Marris

## CEO – Marris Consulting, Paris, France

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- Theory Of Constraints specialist. 29 years of TOC experience. Started working with the founder Eliyahu Goldratt in 1986.
- Consultant (warning!)
- >25 years of experience helping over 150 companies in all industrial sectors.
- Founder and CEO of Marris Consulting based in Paris, France. Founded in 2004. Motto: Factories, People & Results.
- Author of numerous articles on TOC.
- Gives over 10 TOC conferences a year worldwide.
- Author of a very boring French textbook about TOC in manufacturing *Le Management Par les Contraintes*.
- >15 years of experience in major consulting firms.



# Theory Of Constraints marketing & awareness activities

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- 5 Permanent news websites (www.Scoopit.com)
  - Theory Of Constraints (English & French)
  - Critical Chain in (English & French)
  - TLS: TOC + Lean + Six Sigma
- >80 Free Videos (YouTube Channel)
- Discussion Groups (LinkedIn)
  - Critical Chain
  - TLS: TOC, Lean and Six Sigma
- 2 dedicated websites in French
  - TOC in Production
  - TOC in Projects
- Others:
  - Twitter, Facebook, Viadeo, Etc.

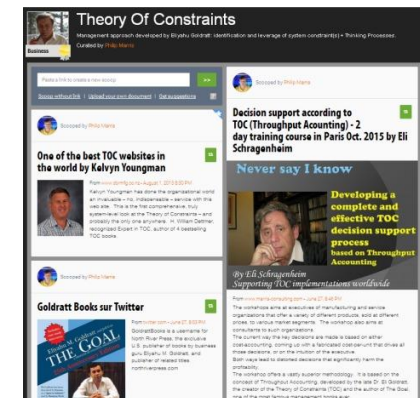
Scoop.it!

YouTube

LinkedIn

twitter

facebook

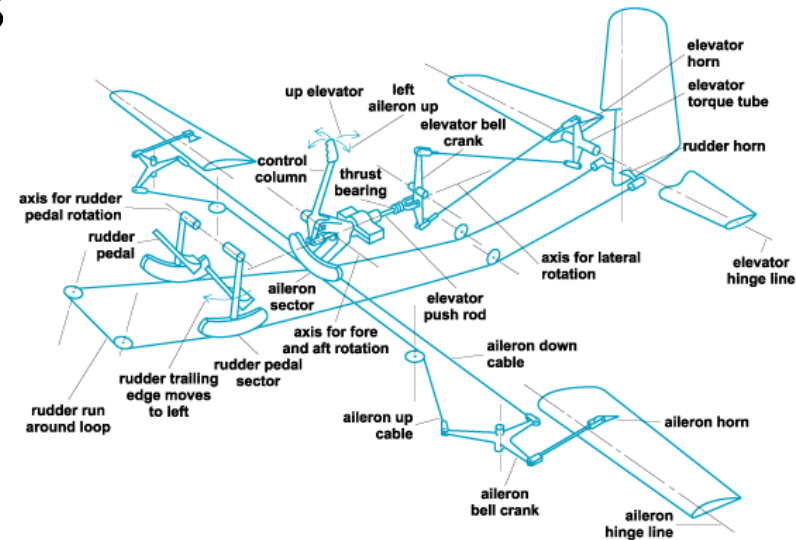


# Case A: Flight Control Systems Equipment Manufacturer

# Flight Control Systems Equipment Manufacturer

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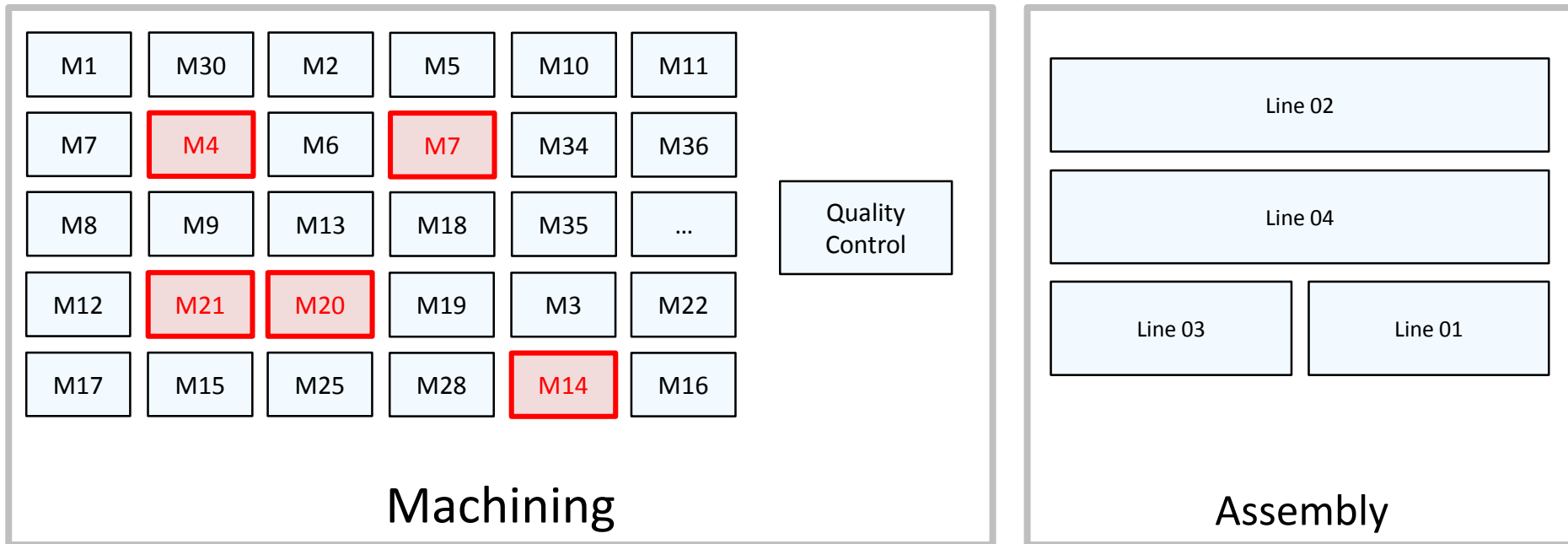
- A 400 person factory in France.  
Part of a major >\$5 billion, >30,000 people, aeronautical equipments world wide leader.
- **Very poor due date delivery performance of <60% OTIF.**  
Unacceptable for it's clients (aircraft manufacturers).
- As a result the plant was loosing business year by year. It's future was compromised.





# Initially they thought that they had 5 capacity bottlenecks

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# So they increased Operating Expenses accordingly

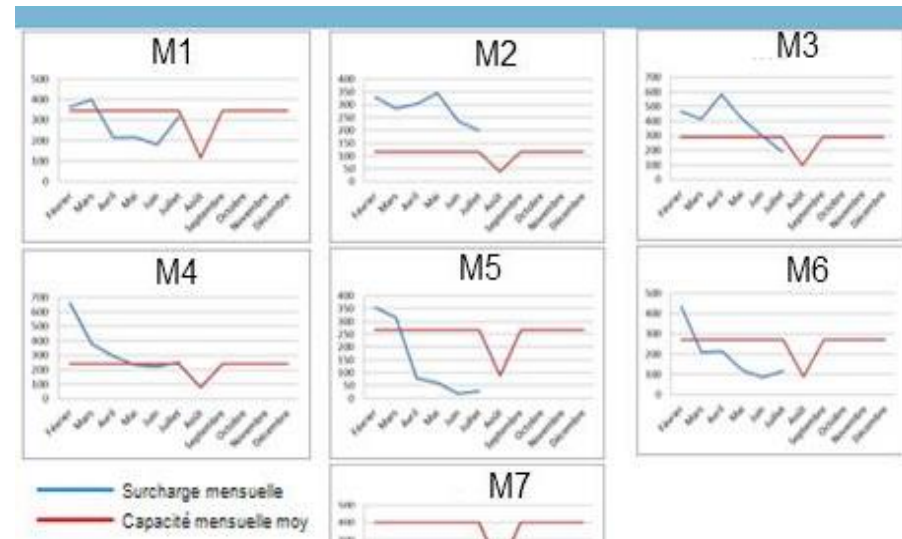
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- SAP / ERP confirmed this overload.

- So they had:

- Overtime,
- Contract Workers,
- Sub-contracting,
- Investments underway,
- Management attention,
- Etc.

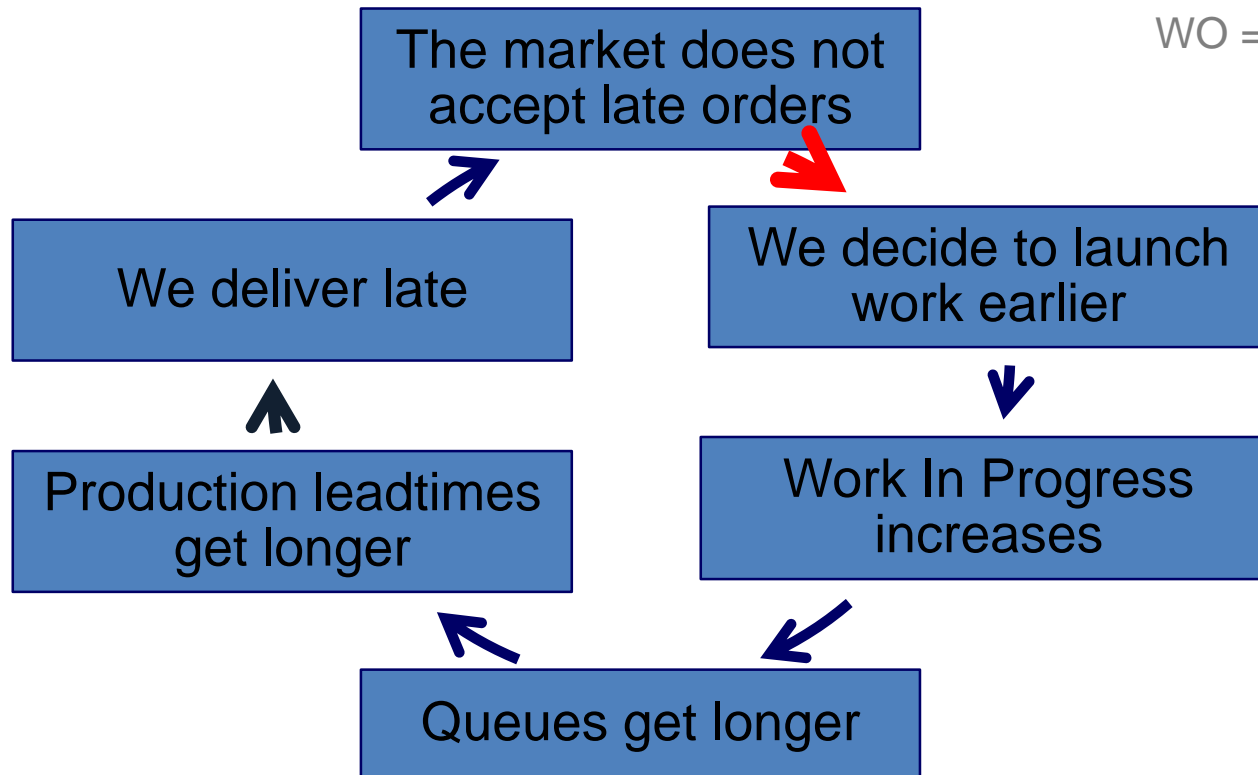
to reduce the load on the bottlenecks



# ...and because they delivered late they started launching WOs\* earlier

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WO = Work Orders



***...which gradually increased  
production lead-times to 9 months***

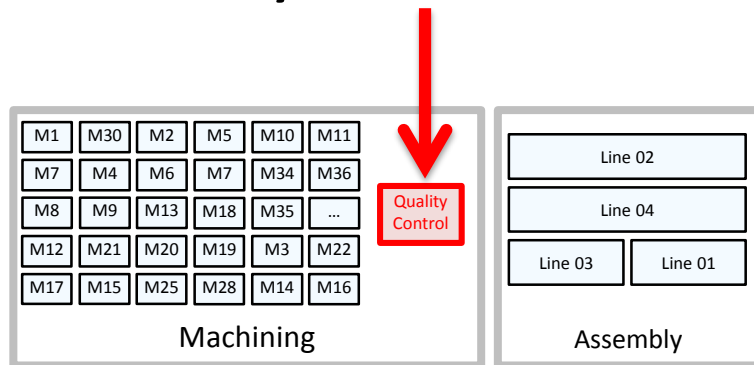
# But there were no improvements. Why?

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# In reality the bottleneck was Quality Control

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- Observing the queues of WIP (Work In Progress) easily showed that the constraint was in Quality Control.



# We then implemented TOC

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- **Exploit** the constraint
  - Management attention + Silly small investments + Increased Manpower
- Reduce WIP and Lead-times
  - Initially NOT by DBR **subordination**...
  - ...but by implementing the "2 for 1 rule"
  - And 3 months later by reducing the batch by 50%

# The "2 for 1" rule

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Very successful simple technique  
Highly recommended

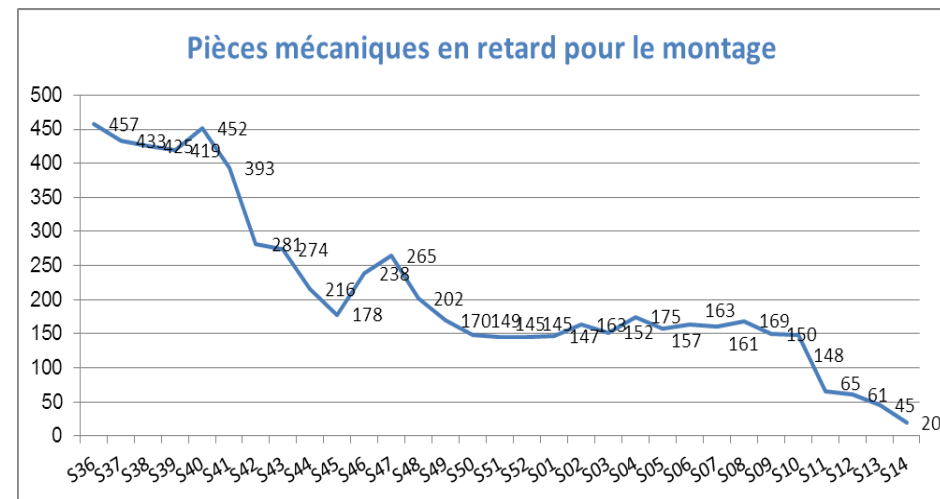
A new Work Order (WO) can only be launched  
when 2 WOs have been completed

- The choice between several WOs proposed by the ERP/MRP is done manually by the management.
- This technique:
  - Is only pertinent for systems with over 50 WOs in WIP
  - Facilitates the transition to other flow control techniques such as DBR.
  - Is neither TOC, nor Lean

# The immediate results were "extraordinaire"

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- Within 2 weeks:  
over 30% increase in plant Throughput and Productivity
- Within 2 months:  
95% reduction in the number of parts missing at assembly

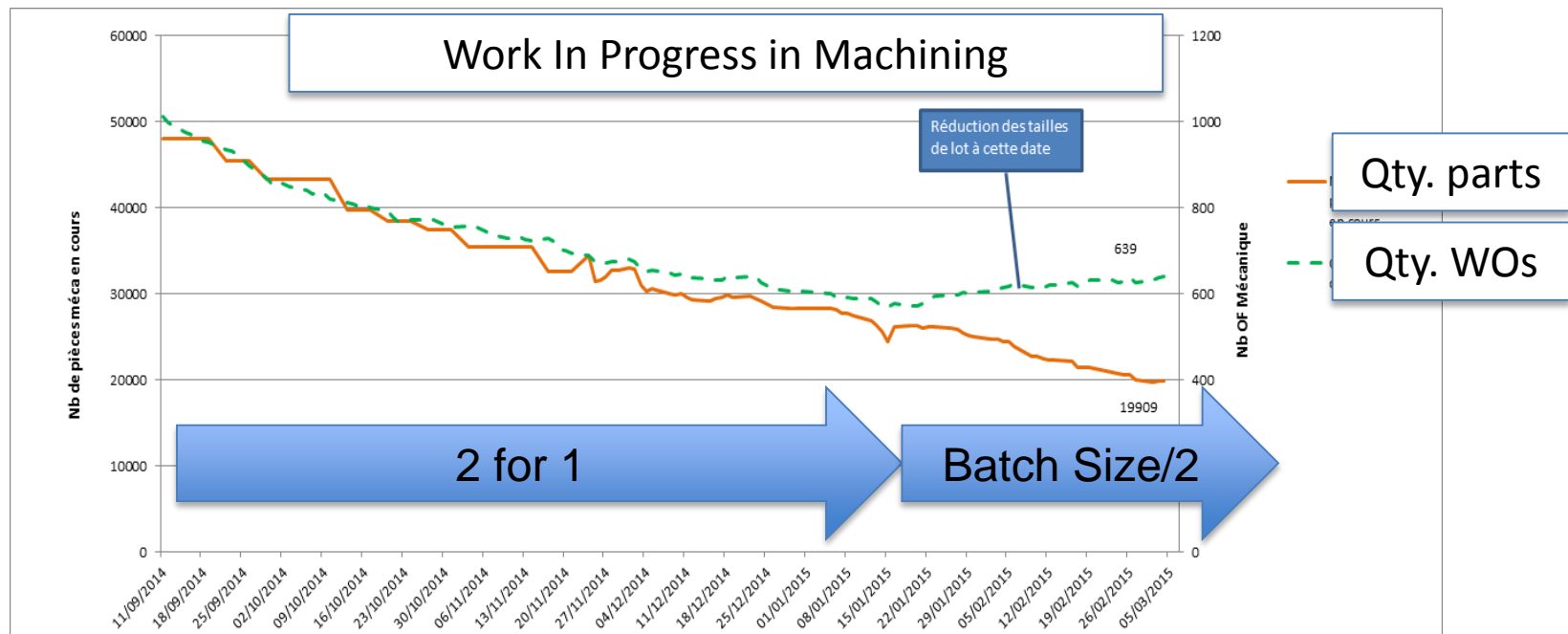




# The results were "extraordinaire"

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- Within 3 months Due Date Performance went from 40% to >80%
- Within 4 months: 70% reduction in WIP and production lead-times
- WIP reduction was over 2.5 M€.
- Factory went from big losses to profits.



# Further improvements are now being implemented

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- The 3 year target is to reduce the lead-time from the initial 9 months to 3 weeks.
- The Due Date performance target is now 95% and 99% the following year.
- Critical Chain Project Management is being implemented to improve new product development.
- Also: Factory layout improvement + SMEDs + Capability and SPC + Training + Etc.

# The TOC Way is spreading in the group

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- A 1 day TOC event was organized with 130 top managers from over 40 factories.
- This plant's story was presented in the group's internal magazine.
- Over a dozen TOC initiatives are underway or being launched in various plants.

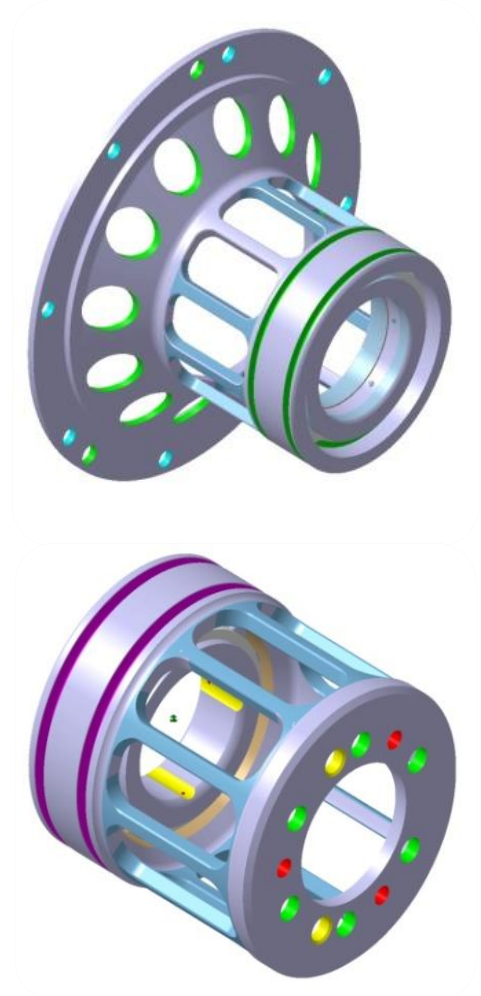


# Case B: Large Sophisticated Aero Ball Bearings

# An aeronautical ball bearing manufacturer

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- >400 people plant
- Part of a world leader / multinational
- Manufacturing sophisticated ball bearings for aircraft engines, helicopter rotors, etc.
- Under pressure to:
  - Improve due date delivery
  - Reduce lead-times
  - Reduce costs

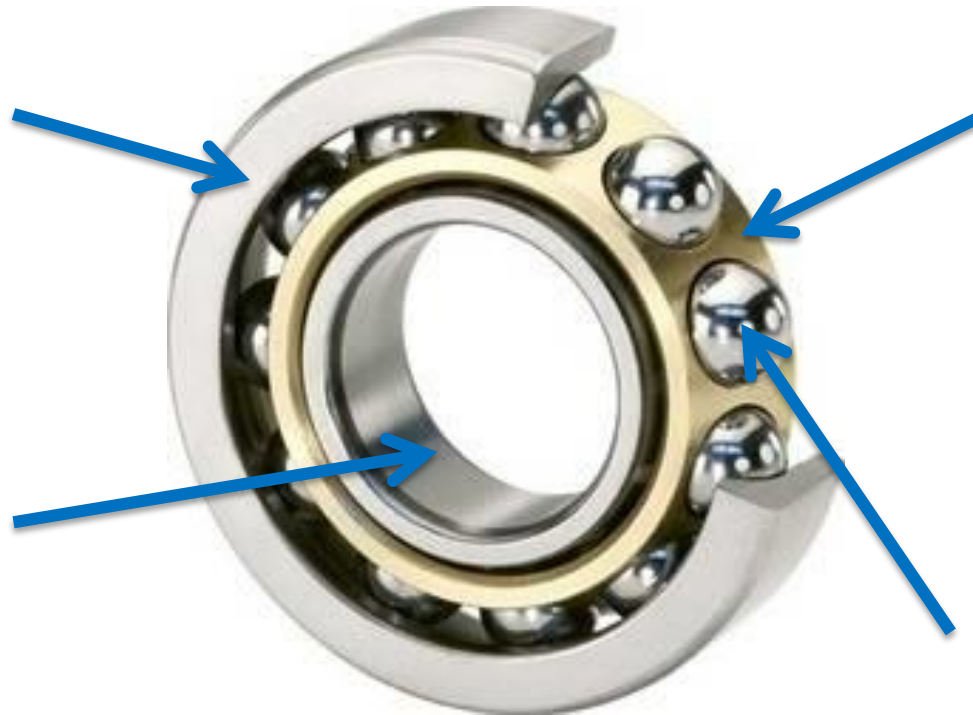


# Bearings = 2 rings + cage + ball bearings

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Outer Ring  
Sophisticated  
very precise  
tolerances

Inner Ring  
Sophisticated  
very precise  
tolerances



Cage  
Simple  
not precise  
tolerance

Ball Bearings  
Average  
complexity

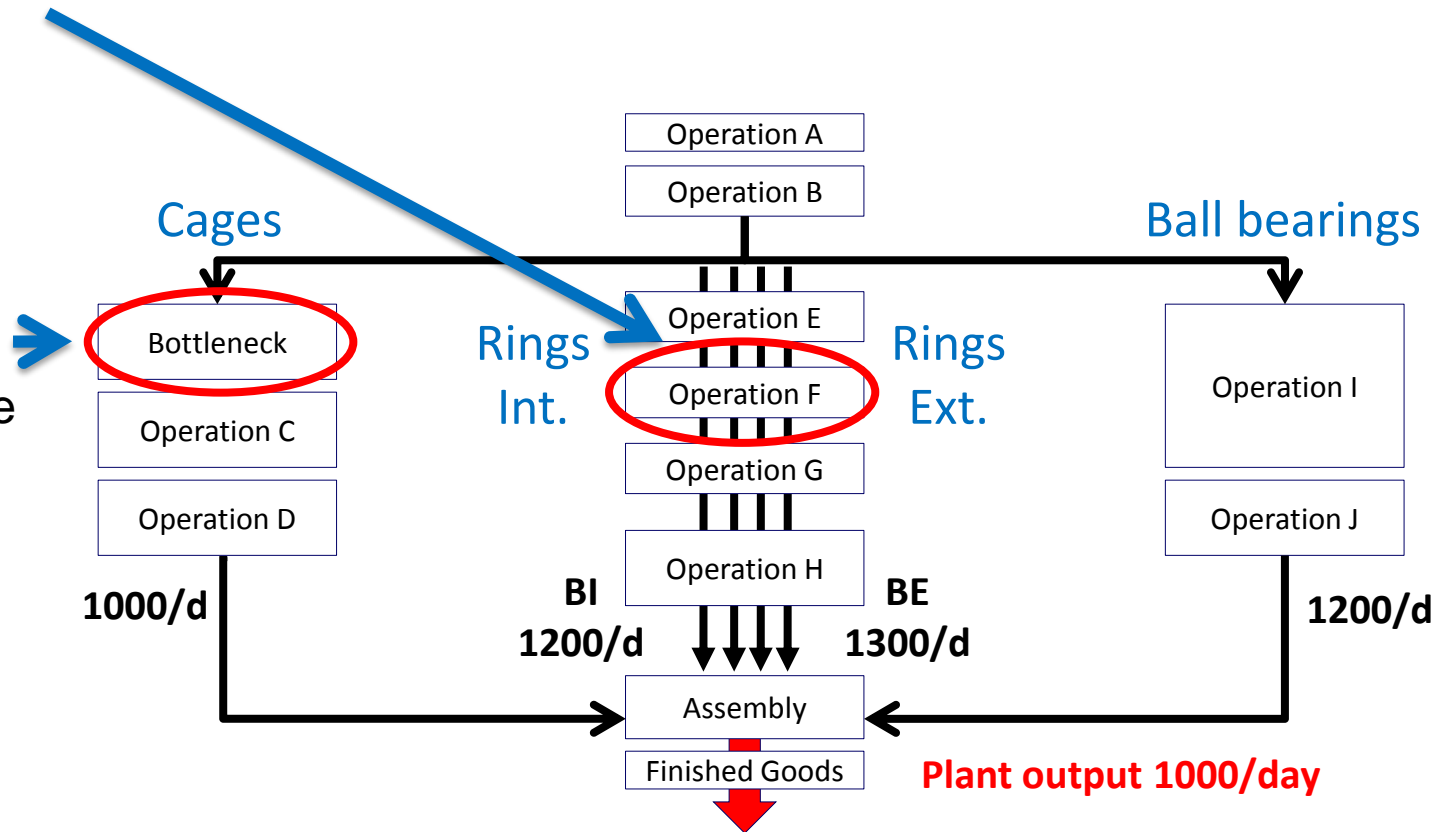
# They were wrong about where the constraint was

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They thought the bottlenecks were their expensive milling machines

when in fact

it was another machine in another part of the factory





# The first 3 steps of the 5 focusing steps were applied

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- Step 1: The (real) constraint was identified
- Step 2: The bottleneck was "elevated"
  - Management attention was sufficient!
  - As volumes increased an external sub-contractor (surface treatment) emerged as the next constraint and was dealt with.
- Step 3: The rest of the plant was "subordinated"



# The results surprised them

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- Global productivity increased significantly.
- The order backlog was dealt with.
- The end of month "hockey stick" was eliminated.
- The "fire fighting" culture disappeared.

# The system was then organized around the "best constraint"

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- There was agreement that the "best constraints" in the plant were the expensive high precision machines.
- So within 4 months the production flow system was reorganized accordingly.

# Case C: Small Aero Ball Bearings

# A success story triggered by only 2 days of TOC training

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- A production manager followed a 2 day training course about applying TOC in Production and then implemented DBR etc.

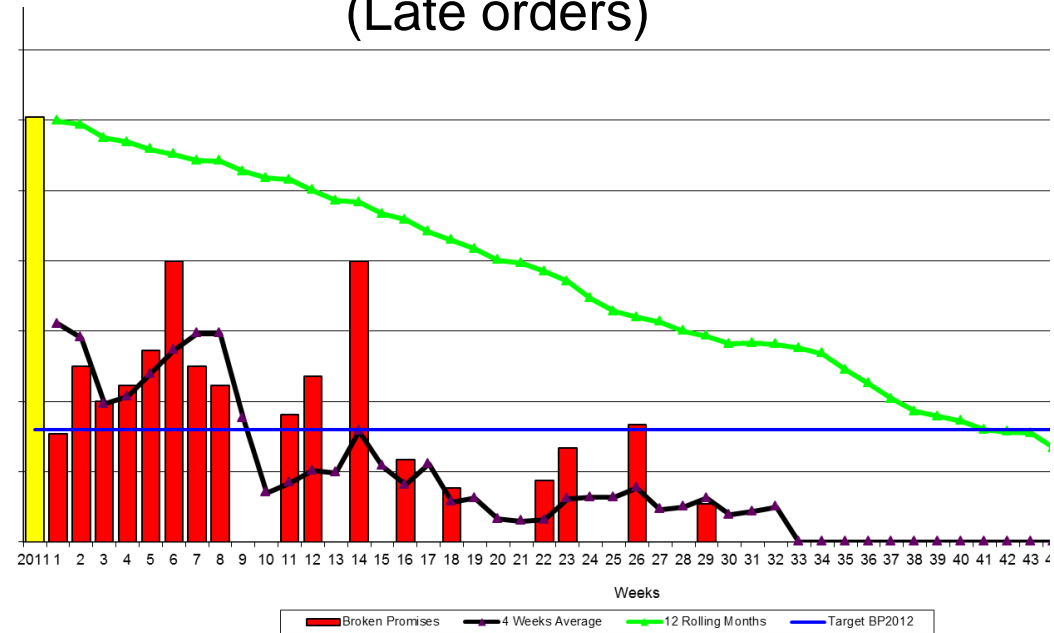


# "Standard" TOC results generated new business

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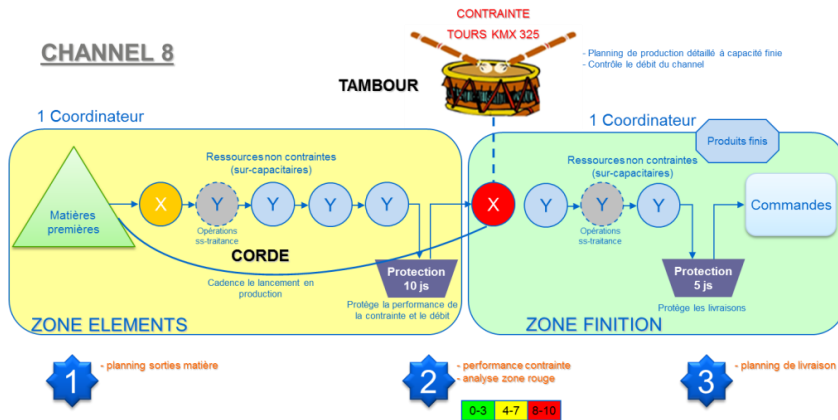
- Due Date Performance from 70% to **100.00%**
- WIP reduction from -35% to -50%
- Productivity +>20%
- Significant impact on company image & reputation which generated a lot of new business.

"Broken Promises"  
(Late orders)

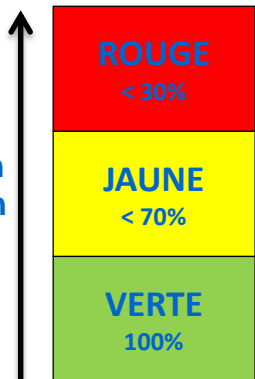


# Very good buffer management POOGI (Process Of On-Going Improvement)

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Consommation de la protection



**BUFFER TEMPS**

- Agir
- Suivi - Pas d'action

										3 à 6			6 à 9					
										PUF								
Code	Désignation article	No OF	Opé.	P.T.	Qté	Fin planif.	Fin réelle	Retard	Arrêt	ANALYSE - retard	Root cause							
631007	BI RE 6.35	1000904371	40	812	150.000	03.09.2014	16.09.2014	13	1	change rectif alessage								
630915	BI RE 4.2SA2	1000905130	20	1026	1100.000	04.09.2014	05.09.2014	1	8	8 jours de pris en								
631111	BI RL11.11	1000903361	80	880	445.000	04.09.2014	12.09.2014	8	3	surfacage								
632083	BI RL BRSP1-A	1000900276	70	812	350.000	04.09.2014	03.09.2014	1	10	de mis en rouge								
630989	BI WQML19.09RSP2	1000900382	70	811	40.000	05.09.2014	06.09.2014	1	8	de terminé								
631199	BI BQMAY17	1000900298	100	832	20.000	05.09.2014	16.09.2014	11	1	of en rectif alessage								
630930	BI WYMA 4	1000900296	50	1026	97.000	08.09.2014	16.09.2014	8	1	besoin produit fin au 03.10								
630973	BI RE 5	1000900293	70	812	160.000	08.09.2014	11.09.2014	3	4	of en rectif alessage								
630987	BB RL 6.35	1000905204	10	828	0.000	08.09.2014	08.09.2014	0	5	mettre en rouge								
631200	BI RL20	1000904268	70	811	50.000	08.09.2014	10.09.2014	2	7	rect sphère besson 01.10								
631227	BI QML22.22	1000904278	10	830	0.000	08.09.2014	08.09.2014	0	7	rect alessage besson 29/09								
631735	BI QML11.11	1000903622	40	811	200.000	08.09.2014	11.09.2014	3	4	a mettre en rouge								
631143	BI RE14.29	1000902331	70	811	10.000	09.09.2014	10.09.2014	1	5	rectif alessage besson 29/09								
631265	BI WQML325.4RSP2	1000900295	80	811	45.000	09.09.2014	10.09.2014	1	6	attente matière								
631761	BI RE11.11-A	1000903415	70	811	50.000	09.09.2014	11.09.2014	2	4	relance								
631811	BI RE15.07A	1000902416	70	811	50.000	09.09.2014	09.09.2014	0	6									
633005	CE 101 127 GT	1000907381	60	R108	300.000	09.09.2014	09.09.2014	0	6									
630987	BB RL 6.35	1000906027	10	828	0.000	10.09.2014	10.09.2014	0	6									
631000	BI RL 6	1000902112	60	1021	50.000	10.09.2014	10.09.2014	0	6									
631325	BI QML14.29SP5-A	1000902140	40	1025	80.000	10.09.2014	10.09.2014	0	6									
631102	BI RE10	1000901838	100	840	0.000	10.09.2014	10.09.2014	0	6									
631255	BI RT22.22	1000903553	100	840	0.000	10.09.2014	10.09.2014	0	6									
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631020	BI RL 6	1000903553	100	840	0.000	10.09.2014	10.09.2014	0	6									
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631020	BI RL 6	1000903553	100	840	0.000	10.09.2014	10.09.2014	0	6									
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631020	BI RL 6	1000903553	100	840	0.000	10.09.2014	10.09.2014	0	6									
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631020	BI RL 6	1000903553	100	840	0.000	10.09.2014	10.09.2014	0	6									
631020	BI RL 6	1000903553	100	840	0.000	10.09.2014	10.09.2014	0	6									
631020	BI RL 6																	

# Conclusion

# TOC and aeronautical manufacturing: a match made in heaven

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- In 2015 aircraft manufacturers must:
  - Produce more (increase Throughput)
  - Reduce WIP for speed and \$\$\$
  - Improve efficiency to reduce costs
  
- The Theory Of Constraints has a great track record of very rapidly:
  - Increasing Throughput
  - Improving flow (& reducing WIP)
  - Improving T/O.E. (Throughput / Operating Expense)





# Thank you for your valuable time

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## Any questions?

# Annexes

# Marris Consulting's YouTube Channel (name: marrisconsulting)



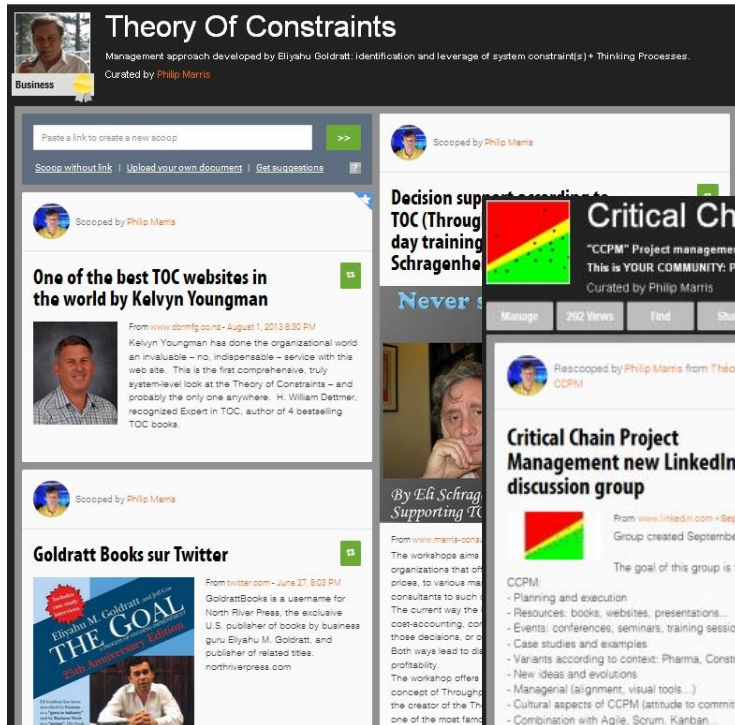
## 2015 TOCICO International Conference – Cape Town, South Africa

<p>Unleashing the potential of Throughput Accounting Workshop by Schragenheim Oct...</p> <p>63 vues • il y a 2 semaines</p>	<p>TOC + Lean in Manufacturing - Vilnius</p> <p>66 vues • il y a 3 semaines</p>	<p>"2 for 1" rule to reduce WIP</p> <p>270 vues • il y a 4 semaines</p>	<p>Marris Consulting YouTube Channel</p> <p>45 vues • il y a 4 semaines</p>	<p>TOCICO 2015 Annual Conference Theory Of Constraints in aeronautical production (3 min. preview of ...</p> <p>37 vues • il y a 1 mois</p>	<p>TOCICO 2015 Annual Conference Theory Of Constraints in aeronautical production (30 sec. preview of ...</p> <p>12 vues • il y a 1 mois</p>
<p>European 6-Day Training Logical Thinking Process</p> <p>42 vues • il y a 1 mois</p>	<p>Bill Dettmer's Logical Thinking Process Participants Testimonials</p> <p>57 vues • il y a 1 mois</p>	<p>Clarke Ching "Rolling Rocks Downhill" book writing saga</p> <p>39 vues • il y a 3 mois</p>	<p>Logical Thinking Process Executive Summary Tree by Bill Dettmer</p> <p>227 vues • il y a 3 mois</p>	<p>Clarke Ching interview extract Theory Of Constraints 5 Focusing Steps Revisited</p> <p>204 vues • il y a 3 mois</p>	<p>Logical Thinking Process 2014 course Intro. to 2014 video sessions</p> <p>54 vues • il y a 5 mois</p>
<p>European 6-Day Training Course - June 2015 Logical Thinking Process</p> <p>106 vues • il y a 5 mois</p>	<p>Bill Dettmer Logical Thinking Process and change</p> <p>76 vues • il y a 5 mois</p>	<p>Eric Robin et Christian Hohmann Management de projets Chaîne Critique</p> <p>337 vues • il y a 5 mois</p>	<p>Bill Dettmer "He Said, She Said" book review</p> <p>55 vues • il y a 5 mois</p>	<p>Philip Marris and Eric Robin Schéma des cuves et 3 types de contraintes</p> <p>447 vues • il y a 6 mois</p>	<p>Bill Dettmer and Philip Marris Theory Of... Thinking Processes and Policy</p> <p>239 vues • il y a 6 mois</p>
<p>Formations Théorie des Contraintes pour booster vos démarches Lean LE BUT</p> <p>208 vues • il y a 6 mois</p>	<p>Problèmes et dilemmes du management de projets classique par Eric Robin</p> <p>665 vues • il y a 7 mois</p>	<p>Interview de Philip Marris par Christian Hohmann</p> <p>665 vues • il y a 7 mois</p>	<p>Eli Schragenheim Throughput Based Decision Making by Eli</p> <p>845 vues • il y a 7 mois</p>	<p>Thermodynamics of Eternity Logical Thinking Process (a humorous example)</p> <p>313 vues • il y a 8 mois</p>	<p>Logical Thinking Process Erik Mano and Philip Marris</p> <p>304 vues • il y a 8 mois</p>
<p>Bill Dettmer video series Coming soon on your screens</p> <p>0:33</p>	<p>Bill Dettmer Logical Thinking Process 6 day training course</p> <p>19:08</p>	<p>Bill Dettmer New videos coming soon!</p> <p>0:56</p>	<p>Logiciels Chaîne Critique</p> <p>5:57</p>	<p>Le Management de Projets par la Chaîne Critique le cnam Pays de la Loire</p> <p>52:19</p>	<p>Le Management de Projets par la Chaîne Critique le cnam Questions &amp; Réponses</p> <p>17:03</p>



# 3 permanent news websites dedicated to the Theory Of Constraints, CCPM and TLS

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**Theory Of Constraints**  
Management approach developed by Eliyahu Goldratt: identification and leverage of system constraint(s) + Thinking Processes.  
Curated by Philip Marris

Paste a link to create a new scoop >>>

Scoop without link | Upload your own document | Get suggestions

Scooped by Philip Marris

**One of the best TOC websites in the world by Kelvyn Youngman**

From [www.dorffg.co.nz](http://www.dorffg.co.nz) - August 1, 2013 8:30 PM

Kelvyn Youngman has done the organizational world an invaluable – no, indispensable – service with this web site. This is the first comprehensive, truly system-level look at the Theory of Constraints – and probably the only one anywhere. H. William Dettmer, recognized Expert in TOC, author of 4 bestselling TOC books.

Scooped by Philip Marris

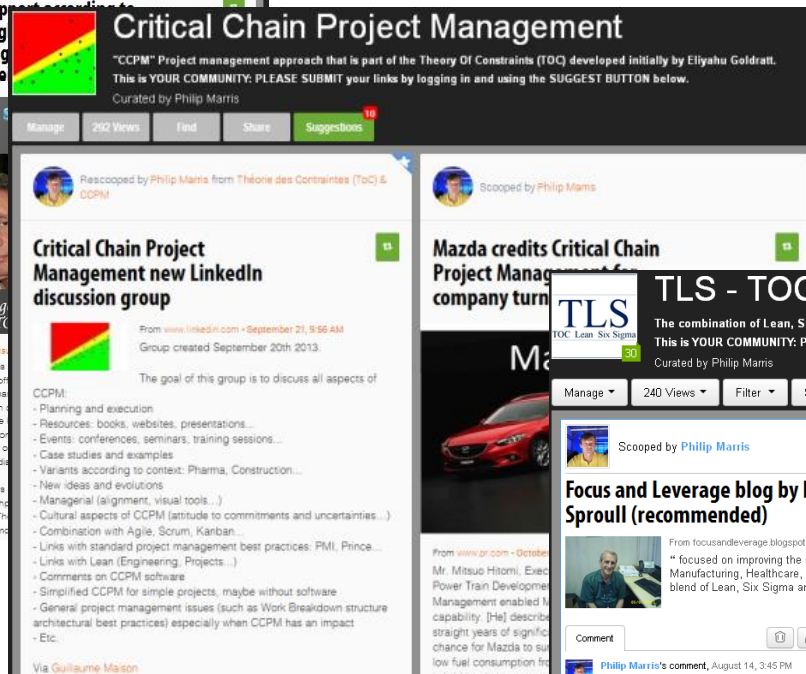
**Goldratt Books sur Twitter**

From [twitter.com](https://twitter.com) - June 27, 8:03 PM

GoldrattBooks is a username for North River Press, the exclusive U.S. publisher of books by business guru Eliyahu M. Goldratt, and publisher of related titles. [northriverpress.com](http://northriverpress.com)

The workshop aims organizations that of prices, to various ma consultants to such The current way the cost-accounting, cor those decisions, or o Both ways lead to di profitability. The workshop offers concept of Through the creator of the Th one of the most fam

[www.scoop.it/t/theory-of-constraints-by-philip-marris](http://www.scoop.it/t/theory-of-constraints-by-philip-marris)  
[www.scoop.it/t/critical-chain-project-management](http://www.scoop.it/t/critical-chain-project-management)  
[www.scoop.it/t/tls-toc-lean-six-sigma](http://www.scoop.it/t/tls-toc-lean-six-sigma)



**Critical Chain Project Management**  
"CCPM" Project management approach that is part of the Theory Of Constraints (TOC) developed initially by Eliyahu Goldratt.  
This is YOUR COMMUNITY. PLEASE SUBMIT your links by logging in and using the SUGGEST BUTTON below.  
Curated by Philip Marris

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Scooped by Philip Marris from *Théorie des Contraintes (ToC) & CCPM*

**Critical Chain Project Management new LinkedIn discussion group**

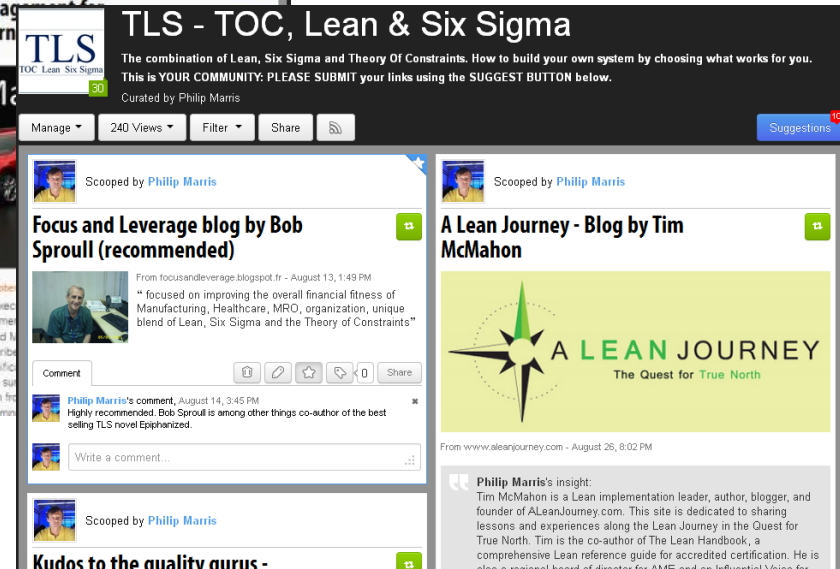
From [www.linkedin.com](http://www.linkedin.com) - September 21, 9:56 AM  
Group created September 20th 2013.

The goal of this group is to discuss all aspects of

CCPM:

- Planning and execution
- Resources: books, websites, presentations...
- Events: conferences, seminars, training sessions...
- Case studies and examples
- Variants according to context: Pharma, Construction...
- New ideas and evolutions
- Managerial (alignment, visual tools...)
- Cultural aspects of CCPM (attitude to commitments and uncertainties...)
- Combination with Agile, Scrum, Kanban...
- Links with standard project management best practices: PMI, Prince...
- Comments on CCPM software
- Simplified CCPM for simple projects, maybe without software
- General project management issues (such as Work Breakdown structure architectural best practices) especially when CCPM has an impact
- Etc.

Via Guillaume Maison



**TLS - TOC, Lean & Six Sigma**  
The combination of Lean, Six Sigma and Theory Of Constraints. How to build your own system by choosing what works for you.  
This is YOUR COMMUNITY. PLEASE SUBMIT your links using the SUGGEST BUTTON below.  
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**Focus and Leverage blog by Bob Sproull (recommended)**

From [focusandleverage.blogspot.fr](http://focusandleverage.blogspot.fr) - August 13, 1:49 PM

"focused on improving the overall financial fitness of Manufacturing, Healthcare, MRO, organization, unique blend of Lean, Six Sigma and the Theory of Constraints"

Comment

Philip Marris's comment, August 14, 3:45 PM  
Highly recommended. Bob Sproull is among other things co-author of the best selling TLS novel Epiphany.

Write a comment...

Scooped by Philip Marris

**Kudos to the aualtv aurus -**

Scooped by Philip Marris

**A Lean Journey - Blog by Tim McMahon**

From [www.aleanjourney.com](http://www.aleanjourney.com) - August 26, 8:02 PM

Philip Marris's insight:  
Tim McMahon is a Lean implementation leader, author, blogger, and founder of ALeanJourney.com. This site is dedicated to sharing lessons and experiences along the Lean Journey in the Quest for True North. Tim is the co-author of The Lean Handbook, a comprehensive Lean reference guide for accredited certification. He is also a frequent speaker at ASME and an influential voice for



# Philip Marris

## Biography

2015 TOCICO International Conference – Cape Town, South Africa

Philip Marris is CEO of Marris Consulting, a management consultancy focused on industrial operations based in Paris, France. Over 80% of the firm's projects are based on the Theory Of Constraints.

He is the author of the French reference book *Le management par les contraintes en gestion industrielle*. He is involved in the “TOC + Lean” movement and founder of the LinkedIn “TLS - TOC Lean & Six Sigma” group and 5 Scoop It TOC related information websites.

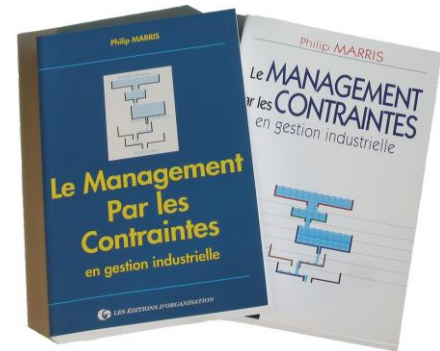
He has designed, sold and executed over 150 transformation projects.

He is a member of the board of the TOCICO French regional group and is active in increasing the awareness of TOC worldwide.

He started his TOC journey in 1986 when he joined Creative Output France and had the honor and pleasure of working with Eli Goldratt and Issi Pazgal.

Philip Marris was for many years in charge of Manufacturing Operations in large consulting firms.

He has over 29 years of experience in industry and in consulting. Philip Marris started his career as a production engineer in the steel industry. He is English and is bilingual and bi-cultural. He lives in Paris, France.



# Full abstract

# TOC to boost aeronautical manufacturing performance

## Philip Marris

2015 TOCICO International Conference – Cape Town, South Africa

3 different cases will be presented; 3 different factories of large well known actors of the aeronautical industry. In all cases the Theory Of Constraints was the main guiding approach but blended into a Lean or Lean Six Sigma environment.

In factory A, the plant manager had read the Goal and already successfully applied TOC in a previous plant. The 400 person plant suffered from very poor due date performance, quality problems and very poor financial performance. SAP had been used to identify the bottleneck resources; 12 key expensive machines were thought to be the constraints. A 4 hour analysis on the shop floor showed that in fact the bottleneck was elsewhere; in the quality control department. Having identified the constraint it was then exploited. This increased the Throughput and the productivity of the whole factory by over 30% in less than 2 weeks. To reduce the excessive level of WIP the “2 for 1” rule was applied: a new Work Order could only be launched once 2 Work Orders had been completed. This generated a growing list of Work Orders whose launch was overdue. When there were too many, the wait times in the SAP ERP were reduced. The improvement process was to first improve the plant physically and then, afterwards, explain to the ERP what the improvements were. Other actions were: batch sizes were divided by 2, sub-contracted work was reintegrated, the priority system was redefined, the plant was reorganized, the assembly process was re-engineered for one piece flow ... The delivery due date performance quickly went from 50% to 85% and the target is now 99%.

In factory B, a manager attended a 2 day course on the Theory Of Constraints in manufacturing and then went away and implemented it alone in his 50 person production unit. The due date performance went from 70% to 100.00% which had a strong impact on obtaining new sales with a major aircraft manufacturer. The production lead-times and the work in progress were divided by 2. Many other improvements were also made. The TOC system was then rolled out to the rest of the 300 person factory.

In factory C, TOC was injected into their pre-existing Lean Six Sigma management system. The management thought that they had identified the bottleneck but in fact the bottleneck was elsewhere. Once the real constraint had been identified it was properly exploited. As a result the plant's Throughput and productivity improved by 10% per month for 4 months in a row. In this period some sub-contractors became bottlenecks and this problem was resolved. A strong monthly hockey-stick phenomenon was eliminated. The “best” plant bottlenecks were then identified and the drum-buffer-rope system was applied to manage the flow of each of the 4 production channels.

To conclude the strengths of the Theory Of Constraints applied to these manufacturing environments will be summarized.

# Marris Consulting

## Over 150 assignments in over 10 years

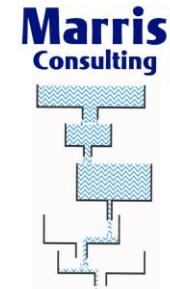
2015 TOCICO International Conference – Cape Town, South Africa



# Marris Consulting

## Paris, France

2015 TOCICO International Conference – Cape Town, South Africa



*Factories, People & Results*



- Marris Consulting has conducted over 150 engagements over the past 10 years, transforming industrial enterprises in France and around the world.
- Clients: ArcelorMittal, GSK (Glaxo Smith Kline), Valeo, Embraer, Safran, SNCF / French Railways, Veolia, Salzgitter Mannesmann, EADS, Aubert & Duval / Eramet, Autoliv, ABB, Man, Michelin, Bobst, Banque de France, DSS / Kaysersberg Packaging, etc. and over 50 Small & Medium Enterprises.
- The firm is recognized as an expert in TOC & Lean Manufacturing. Philip Marris is the author of the TOC reference book in French: *Le Management Par les Contraintes*. Philip is English and worked with Eli Goldratt in the formative years of TOC.
- Marris Consulting conducts **regular training courses in TOC, TLS, Critical Chain** project Management, and other related areas of practice. The courses are delivered in Paris but can be arranged to be conducted at other sites.
- TOC manufacturing & CCPM websites (in French):
  - [www.management-par-les-contraintes.com](http://www.management-par-les-contraintes.com)
  - [www.chaine-critique.com](http://www.chaine-critique.com)
- Founded in 2005, 14 consultants + freelance network

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