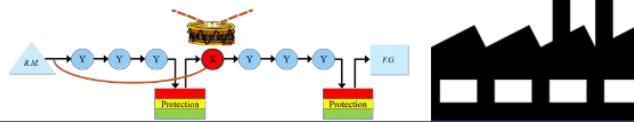


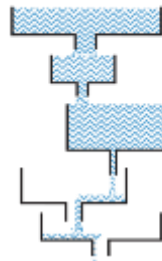
Theory of Constraints in production



The Theory of Constraints applied to Production

Webinar

Marris
Consulting



Paris, Wednesday 13th May 2020

Version 1.0





Agenda

- Introduction
- Presentation of the Theory of Constraints
 - © Marris Consulting
- Case study in the automotive industry
- The 5 focusing steps of the Theory of Constraints
- Case study in the aeronautical industry
- Conclusion
- Annexes

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organization of the webinar

- Presentation : 60 minutes
- Followed by a Questions & Answers session: 30 minutes
- You can ask questions and make written comments throughout the webinar using the "Q. and A." feature at the bottom of the screen (mouse over).
- The presentation material will be available on our website at the end of this webinar.
- There will be surveys during the webinar.
- The webinar is managed by 2 people:
 - **Philip Marris the "speaker"**
 - **And a webinar manager whose role is:**
 - To read the written questions as the webinar progresses
 - To manage the questions and answers session (choice of questions, opening / closing the microphone, etc...)





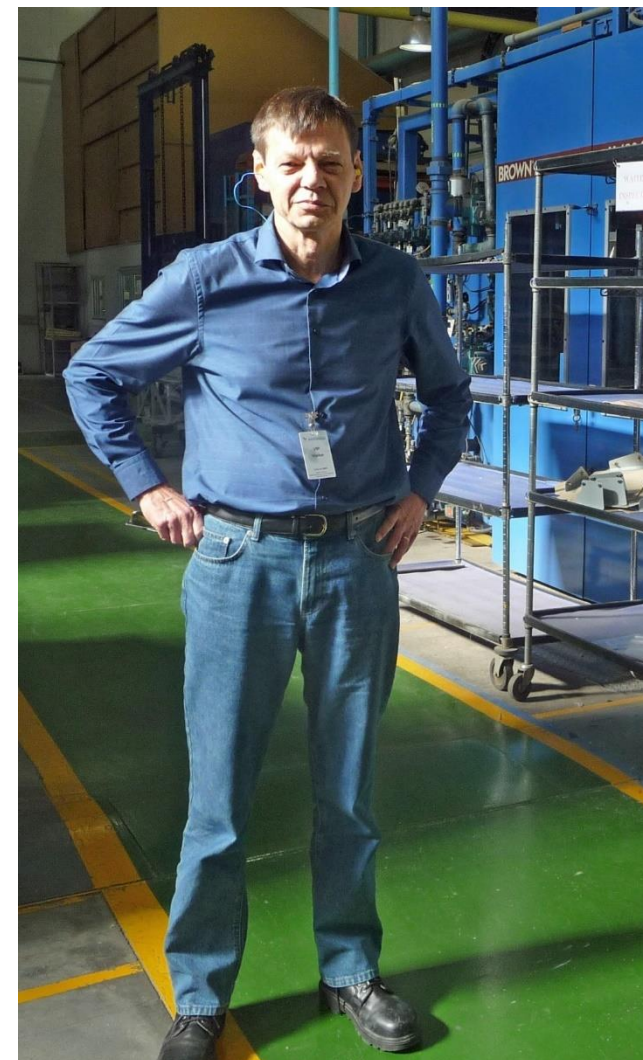
Philip Marris: CEO, Marris Consulting

- English...and European,
- Bilingual & bicultural English/French.
© Marris Consulting
- Consultant (sorry).
- Started using Lean in industry in 1984.
- Has been implementing ToC since 1986, when he worked with Eli Goldratt, the founder of Theory of Constraints/ToC.
- Implementation of ToC and Lean (sometimes also Six Sigma) in more than 260 companies around the world.
- Author of the French reference book on ToC in production: *Le Management Par les Contraintes*.
- Founder in 2005 of Marris Consulting.



Marris Consulting, a consulting firm specialized in operational excellence and project management

- Founded in 2005 by Philip Marris and based in Paris.
- 12 consultants and its network of partners.
- More than 40 conferences and training sessions per year on operational performance, Theory of Constraints, Lean, project management by the Critical Chain ...
- Over 300 videos of customer testimonials, educational presentations, expert interviews, etc.



Experience of more than 260 business transformations worldwide





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The Theory of Constraints gained its global recognition because of the success of the best selling “business thriller” *The Goal* by Eliyahu Goldratt

- Over 7 million copies sold in 32 languages. Mandatory reading in most universities/MBAs/...
- Written by Eliyahu Goldratt the founder of ToC with Jeff Cox.
- The first book of its kind: a novel to explain a new approach to management.
- Chosen as one of the 25 most influential business books by Time magazine in September 2011.
- Used by Jeff Bezos, Amazon.com CEO, to build their Supply Chain and redefine the company's goal.
- New graphic edition in 2017.

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Includes Eli Goldratt's, "Standing on the Shoulders of Giants."

Eliyahu M. Goldratt and Jeff Cox

THE GOAL

A PROCESS OF ONGOING IMPROVEMENT

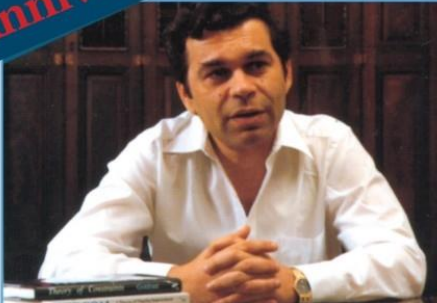
30th Anniversary Edition

Eli Goldratt has been described by **Fortune** as a “guru to industry” and by **Business Week** as a “genius”. His book, *The Goal*, is a gripping fastpaced business novel.

“Goal readers are now doing the best work of their lives.” **Success Magazine**

“A factory may be an unlikely setting for a novel, but the book has been wildly effective...” **Tom Peters**

Required reading for Amazon's management.



THE BEST-SELLING BUSINESS NOVEL THAT INTRODUCED THE

THEORY OF CONSTRAINTS

AND CHANGED HOW AMERICA DOES BUSINESS

OVER 6 MILLION COPIES SOLD!

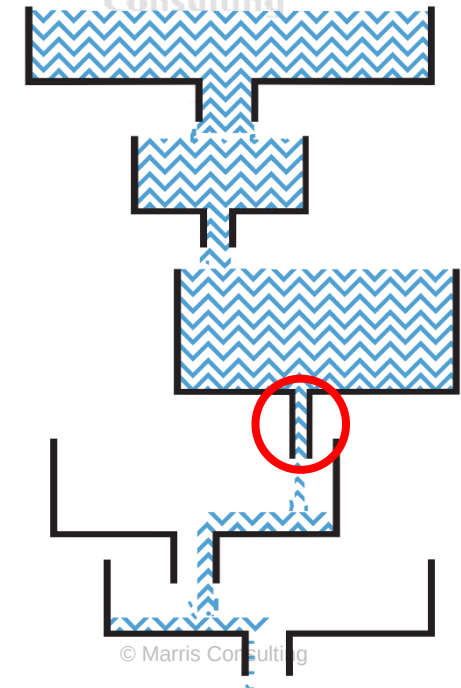




Focus on improving the system constraints that determine the overall performance

*It is no longer possible to distribute work equitably:
organizations are necessarily unbalanced*

- Companies (factories, engineering departments ...) and other organizations inevitably have unbalanced capacities.
- Annual budgets pretend to balance organizations but they don't succeed.
- There is always a constraint somewhere in the system.
- One hour lost on that constraint (the bottleneck)
= one hour lost for the system = one hour of lost sales.
- One hour gained on a non-bottleneck is an illusion. A non-constraint must only work according to the constraints requirements.
- A dual view is mandatory: different rules for constraints and non-constraints.



The sum of local optimums is not equal to the global optimum



The 5 steps of ToC continuous improvement process

1. IDENTIFY the system constraint(s).

Easy to do in production
but not in projects

2. Decide how to EXPLOIT the system constraint.

Without investments
in \$ or in time

3. SUBORDINATE everything else to the above decision.

The most
difficult step

4. ELEVATE the system constraint

With investments
in \$ or in time

5. WARNING!!!!

If in the previous steps a constraint has been eliminated,
go back to step 1,
but do not allow INERTIA to become the system constraint.

Or choose the "best"
constraint of the system

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Note: often called *The 5 Focusing Steps* or *ToC Process of On-Going Improvement (POOGI)*.



The different components of the Theory of Constraints (ToC)

Theory of Constraints (ToC)

Approach initiated by Eliyahu Goldratt
A systemic view seeking the global optimum
based on a dual view of constraints/bottlenecks & non-constraints

Thinking Processes or Logical Thinking Process

This could be considered to be at another higher level than simply a component

Subject of the webinar

Drum – Buffer - Rope Production Management

The importance of constraints,
DBR & S-DBR,
Focused approach, ...

Critical Chain Project Management (CCPM)

Project Buffer (not "local" tasks),
Fever Chart, Critical Chain (not
Path), Bad multitasking, ...

Replenishment (?) Distribution

High frequency periodic
replenishment, stocks centralized
(not too distributed),
[DDMRP?]

Marketing & Sales

Mafia offer or (URO)
+ Decisive Competitive Edge
(DCE) + Delta T-Selling
+ Sales force constraints

Throughput Accounting Financial decision making

T,I,O.E.: Throughput, Inventory
& Operating Expenses, TBDM,
Dollar x Days, Total Variable
Cost, Product Mix

Value Added Computing Information Systems

Data & Information
Necessary but not sufficient
The 6 questions
[Philip Marris' personal opinion]

Thinking Processes Problem resolution

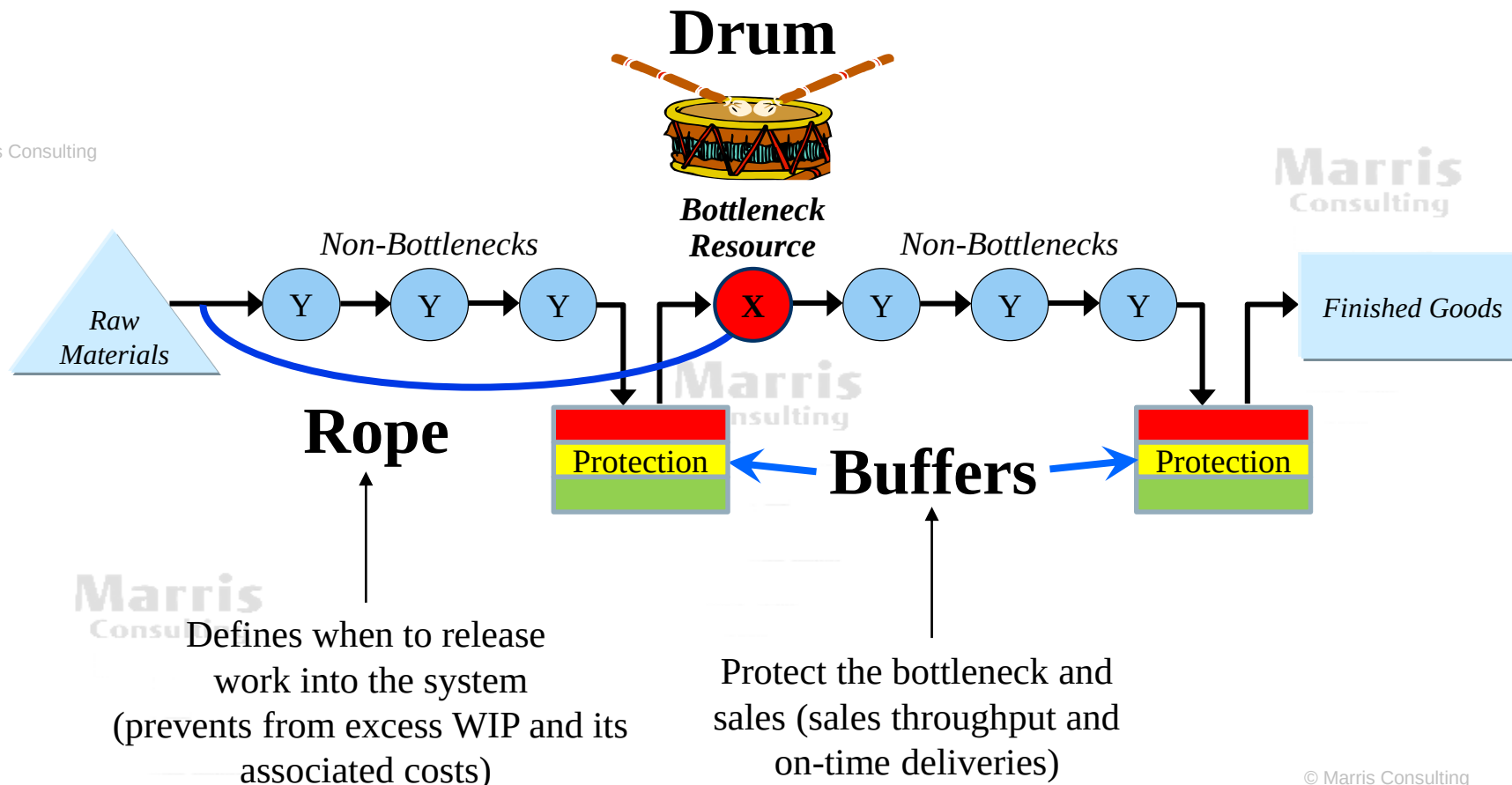
Evaporating Cloud, Goal Tree,
Strategic & Tactic Trees,
Current/Future Reality Tree, Pre-
requisite & Transition Trees

Other new ideas!?

Standing on shoulders of giants,
Behavior & Organizations, Viable
Vision, Strategy,
KM, + new TA ,...?

ToC controls production flow with the Drum Buffer Rope (DBR) mechanism

© Marris Consulting



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One of the key ideas of ToC is to use buffers to protect the bottleneck against variability. We will find a similar mechanism in the ToC project management approach.



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One of the Leanest organizations in the world

- One of the 10 largest automotive OEM suppliers in the world. Over 100 factories.
- Was one of the first to begin its Lean journey after Toyota at the end of the 1970s.
- All the Lean techniques are used: Gemba, SMED, PDCA, 5S, ppm, Andon, Poka Yoke, Kanban, VSM, VSD, 8D, ...
- The plant which manufactures alternators is made up of around twenty autonomous production units.
- Following an excellent positioning of their products, one of their factories in Mexico ended up with a demand significantly higher than its capacity. This situation created great tension with their customers and in particular one of the largest car manufacturers in the world. They risked shutting down their customers' assembly lines.
- Of course they went 5 x 8 (24/7), they launched several investments in new lines but these had lead times of more than 6 months

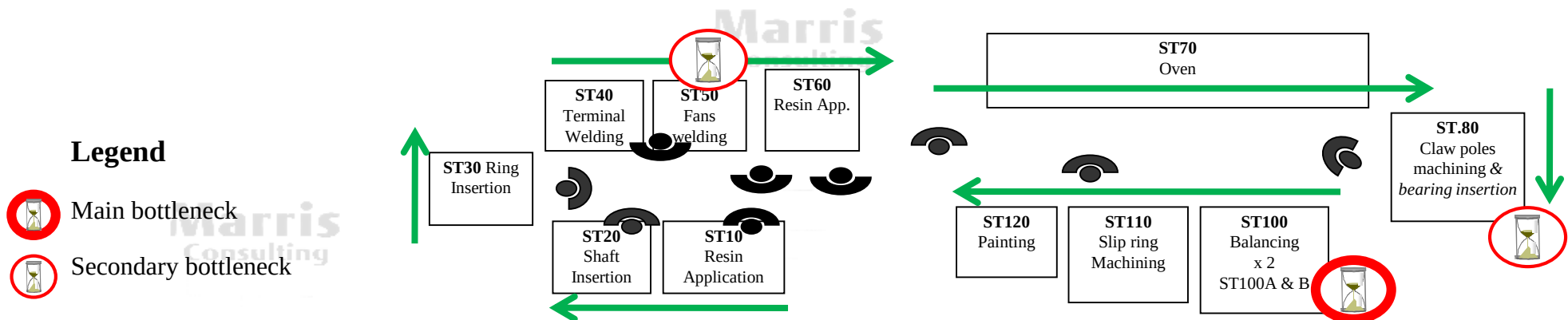
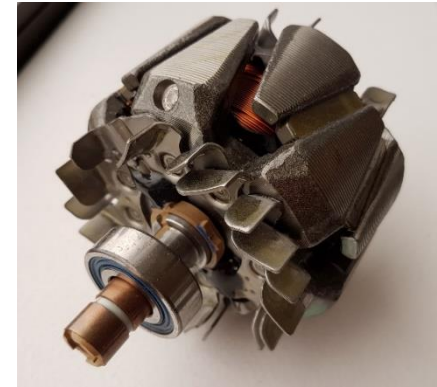
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The problem to be solved: how to increase the volumes of factory shipments almost immediately?



We will focus on one of the bottleneck APU's

- Daily production 6 000 units per day = cycle time 15 seconds
- The system is standard Lean: One piece flow, the O.E.s are approximately 70%, Quality is O.K.
- The bottleneck was already formally identified

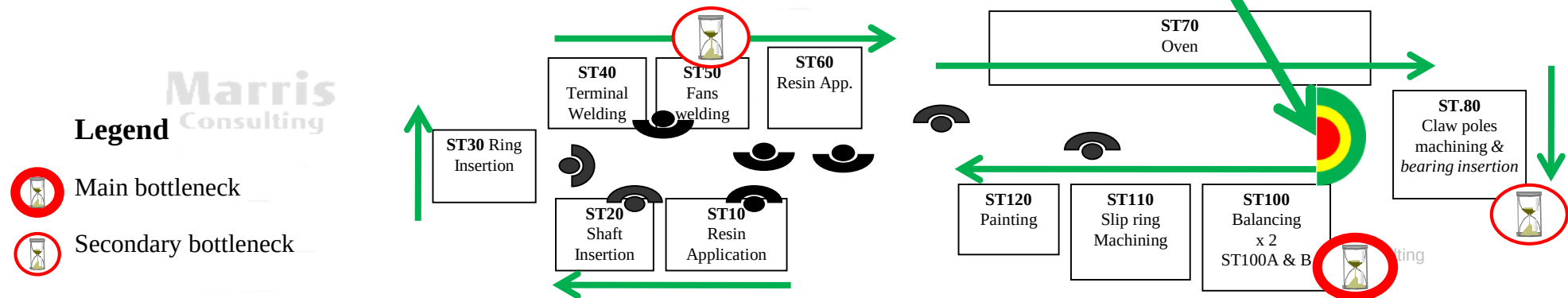


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How to increase throughput by more than 15% in less than 15 minutes !?

The solution: protect the **bottleneck** with a buffer!

- A buffer, initially of about 12 parts, was implemented just in front of the bottleneck operation. This protected the bottleneck from micro stoppages lasting between 1 second and 3 minutes
- This immediately increased the Throughput by 17%
- Also, from that moment onwards, we were able to convincingly mobilize the whole team to adopt the rule « The bottleneck must never stop » and begin a focused improvement process.





Then, how to do it even better in a week?

■ On the bottleneck:

- 25 hour production: breaks, shifts, lunches, 5-minute points, etc.
- carried out by placing a stack of 4 baskets containing 30 minutes of production in front of the neck
- Deal with recurring small breakdowns
- Priority maintenance (preventive and curative)
- Improvement of the production process (sometimes less than a second but ...)
- Etc.

■ On other non-bottleneck resources:

- Reduced scrap rates
- Reduction in the number of long breakdowns (> 1 day)
- Increase in critical spare parts
- Etc.



*See the different videos of this case on YouTube / MarrisConsulting:
French, English, 3 to 30 min*

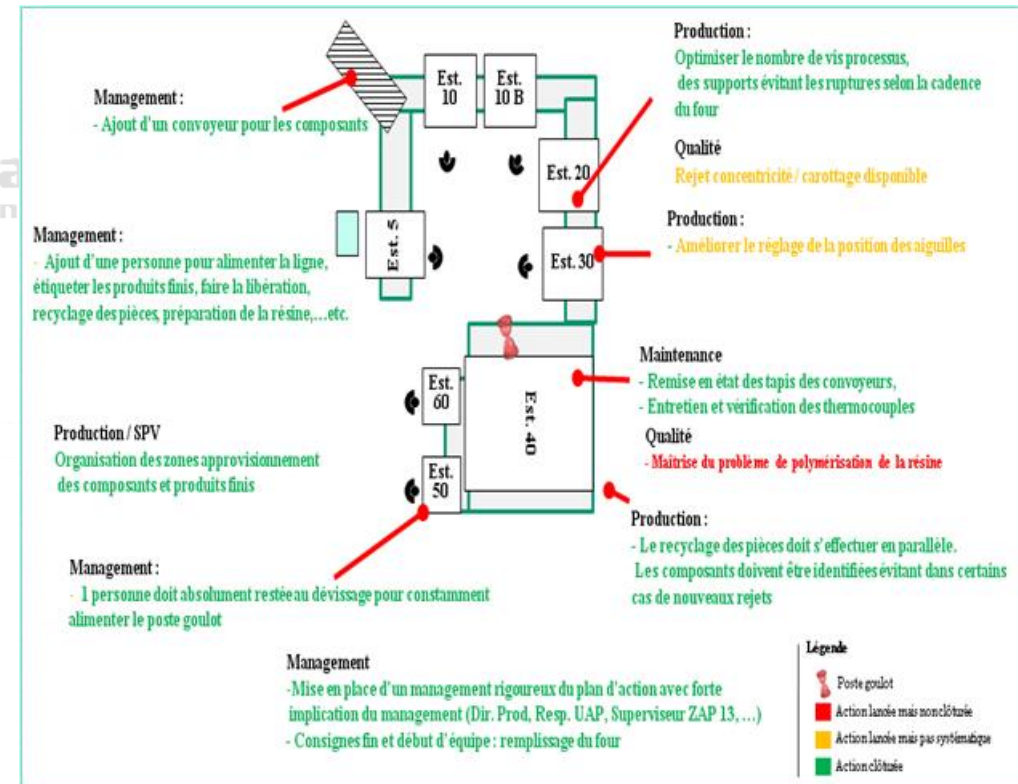
Lessons learnt from this "ToC + Lean" case

ToC

- When there is significant variability, one must recognize that fact and protect the constraint. In this case, they temporarily abandoned their **sacrosanct "one piece flow" rule**.
- The ToC-based buffered flow control very significantly **reduced the level of stress** for the Team Leader and the operators. They felt better to lead small local improvement actions.

Lean

- Simultaneously, a large number of Lean actions were implemented
- Example in another "non-bottleneck" U-Cell:





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1. *Identify the constraints*

A critical and not necessarily easy step

- It is obviously the critical step. How can you apply the Theory of Constraints if you don't know where your constraint is?
- **WARNING!** Today, 80% of companies don't know where their capacity constraint is!
- 15 years ago, 50% of the companies we worked with knew where their bottlenecks were before starting to implement the Theory of Constraints.
- Over the past 15 years (2005 to 2020), we have found that, in 8 cases out of 10, the organization is initially mistaken as to where its capacity constraint is.



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1. Identify the constraints

Use your eyes and your brain...

- This section is Philip Marris' point of view (not orthodox)
- Do not blindly believe the data that comes from your computer system
- Watch the flow (Gemba / field visits):
 - Find the longest line,
 - Check the sources of ruptures,...
- Management is often wrong, operators in the field are often right
- Be careful if the bottleneck is too good to be true



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... and not the computer or the management...

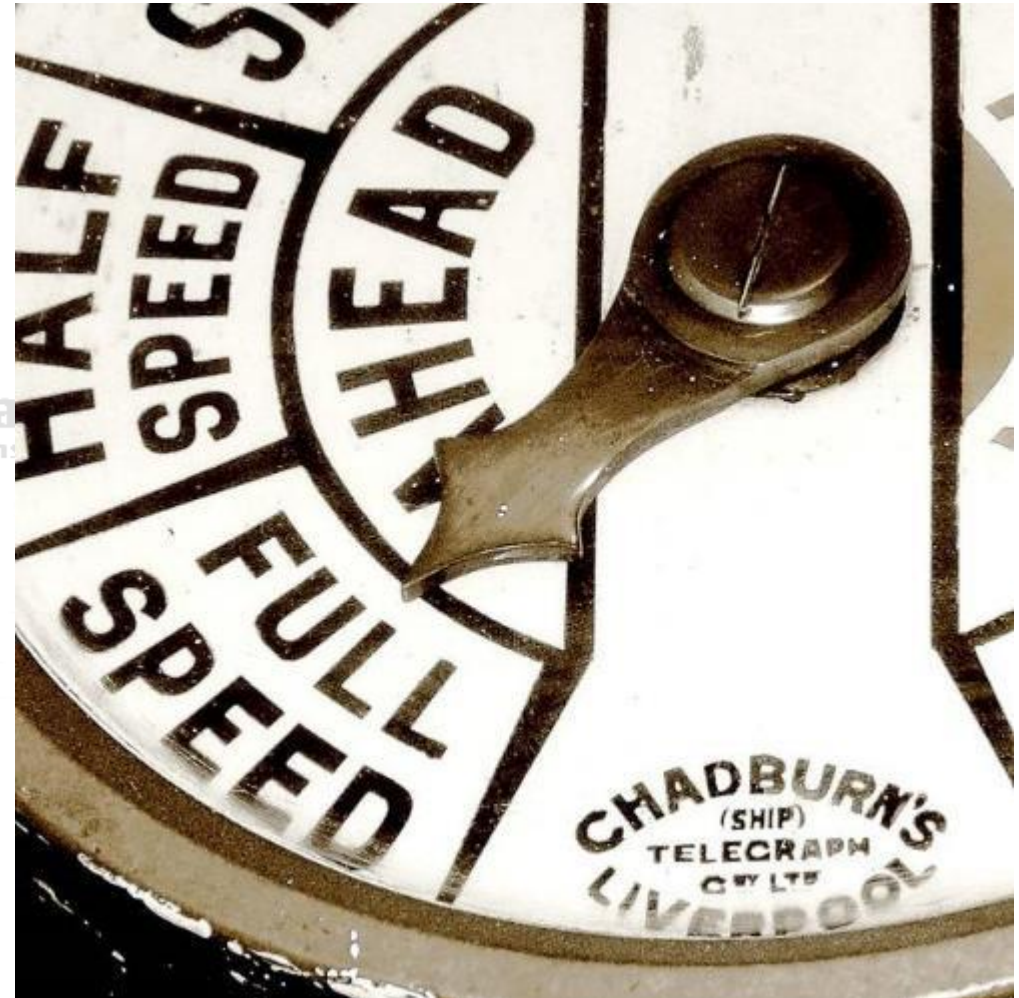




2. *Exploit the constraint:*

Exploiting a constraint is fairly easy

- You concentrate all the company's attention on one resource.
- Everybody loves producing as much as possible.
- Because of the previously diluted efforts (all resources receive identical time and money), there are many low hanging fruits.
- Typically:
 - No stopping during breaks
 - No stopping during shift change-overs
 - First priority for labour shortages
 - First priority for support services such as maintenance and engineering methods.
 - Etc.





2. Exploit the constraint:

...the results are different depending on the country or company

- In emerging countries, for example, we achieve almost 100% exploitation: 8 hours per 8-hour shift.
- But in some companies, it will be difficult to exceed 75% due to:
 - Low work intensity in general
 - The so-called impossibility of:
 - Operating the bottleneck during breaks
 - Preventing the bottleneck from stopping during shift changes
- This results in a significant loss of overall performance.



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*An hour lost on a capacity constraint
is an hour lost for the whole plant*



3. ***SUBORDINATE*** everything else to the above decision

The hardest step of the Theory of Constraints

- Technically, it looks easy: it is just "the rope". Material should only be launched according to the requirements of the constraint.
- But this implies that resources are no longer asked to work according to their own potential (their capacity) but according to capacity of the constraint.
- They must learn to be sub-optimal.
- Thus, all the local measurement systems must be eliminated. Local O.E.E.s (Overall Equipment Effectiveness or machine utilization) for instance must be abolished.
- **You have to learn to stop working.**
- They no longer need to look busy all the time.
- Ideally this new - or rather revealed - rest time should be converted into value-added tasks unrelated to production.

The difficulty with ToC is not the constraints but the non-constraints



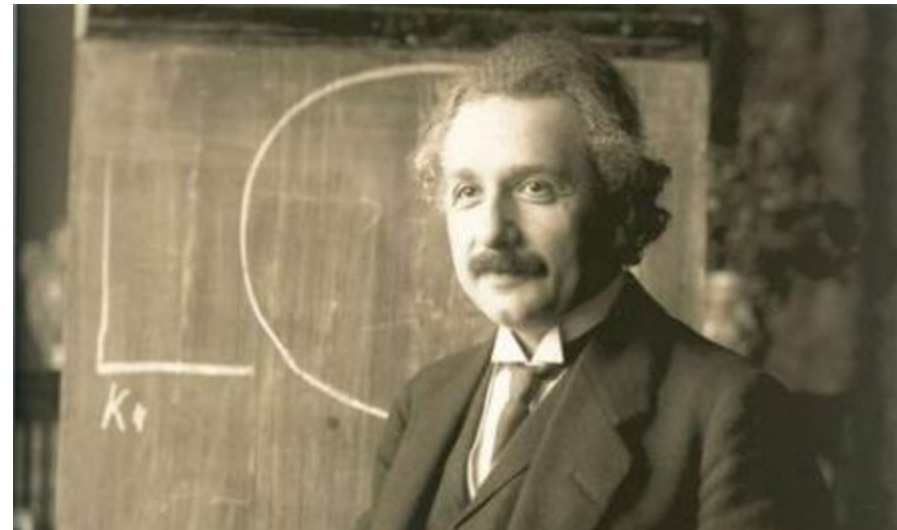
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This is the hardest step of the Theory of Constraints



4. *Elevate the constraint in the system:* A fairly easy step

- To increase the capacity of the system constraint is easy but in some cases it can take time.
- The ROI (Return On Investment) is usually easy to justify since the impact on profitability or Throughput will be very significant.
- It can take time though if:
 - It is a long investment process
 - A rare human capability will have to be grown / nurtured internally
 - It involves regulatory approvals
 - Etc.
- The main danger is miscalculating the excess capacity surrounding the constraint. If in the elevation process the constraint moves elsewhere, then the ROI justification falls apart and the organization is destabilized by "discovering" a new constraint. See next section.





5. *Go back to Step 1 ...or not:*

Choosing the “best” constraint (according to Philip Marris)

The best constraint is the resource which would take the most money and/or time to turn into a non-constraint

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Marris Consulting's point of view

- If you follow standard Theory of Constraints orthodoxy then you just go back to Step 1 and identify the new constraint.
- This means that ToC resembles permanent bottleneck hunting.
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- Paradoxically, it is an attempt to balance the plant.
- And Goldratt's initial axiom was that this was impossible!
- Philip Marris does not agree with the 5th step of the 5 focusing steps.
- Philip Marris suggests:
 - That constraints are eliminated one after the other until one reaches the best (least worse) constraint.
 - An organized / target unbalanced system with the best constraint surrounded by non-constraints.

In his 1994 book in French the subtitle and "Part 2" of the book is called "A la recherche du bon déséquilibre" or "In search of the ideally balanced plant".

1. IDENTIFY the system's constraint(s).
2. Decide how to EXPLOIT the system's constraint
3. SUBORDINATE everything else to the above decision.
4. ELEVATE the system's constraint
5. WARNING!!!!
If in the previous steps a constraint has been eliminated, go back to step 1, but do not allow INERTIA to become the system's constraint.

*The difference concerns
the 5th and last step*

Constraints Management	Theory of Constraints
■ Constraints are eliminated one <u>after</u> the other until one reaches the best (least worse) constraint. ■ An organized / target unbalanced system with the best constraint surrounded by non-constraints.	■ Permanent constraints hunting. ■ There is no such thing as the right or best constraint.





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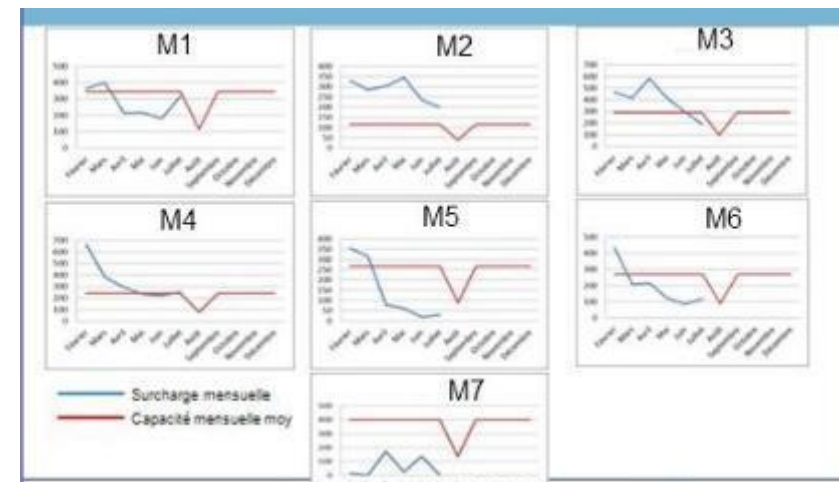
Flight Control Systems Equipment Manufacturer: They thought several machines were their bottleneck

- Delays in order delivery are quickly reported to the chiefs of the Business Unit.
- The site does not have a credible action plan to rectify the situation towards its customers.
- Additional machining hours, Saturday & Sunday.
- The site has set out to subcontract some stages of the process to absorb the load.
- The plant is working to improve SAP's ability to handle the delay.



**TESTIMONIALS ON THE YOUTUBE CHANNEL
OF MARRIS CONSULTING (in French)**

Evolution of the delay on bottlenecks
machines during machining

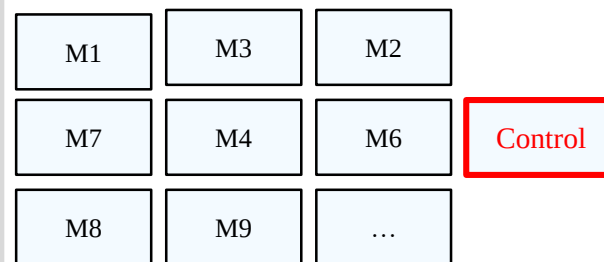


...In reality, the bottleneck of the factory was simply the quality control of the parts

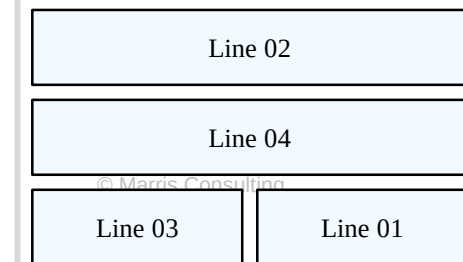


Products pending before Quality Control:

- 370 Work Orders (35%)
- 8 out of 10 "Urgent orders"



Machining



Assembly



Two main complementary projects were launched simultaneously...

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Action #1 : *Exploit the constraint*

- Management attention
- Silly small investments (such as a new photocopier...)
- Increased Manpower (by transfers from non-bottlenecks, not extra labour)
- Increase the local productivity of the control thanks to improvement and managerial actions:
 - Remove redundant checks done upstream,
 - Reorganization of controllers to remove unnecessary flows,
 - Relocate some controls at the subcontractor's level.

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Action #2 : *Subordinate & Reduce WIP*

- Apply the "2 for 1" rule
- Prevent production from scheduling to ensure local productivity.
- Focus the efforts of the support functions (methods, quality ...) on the resolution of the priority Work Orders.
- Do not launch WOs to keep the machines busy
- ...

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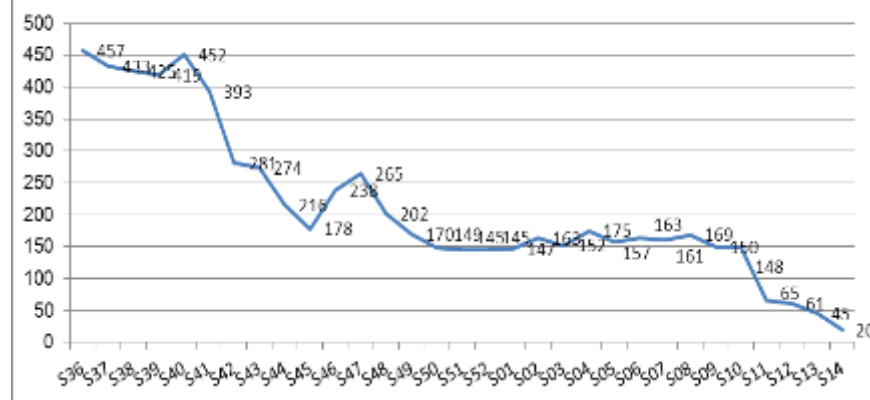


...and concrete results were quickly seen (#1/2)



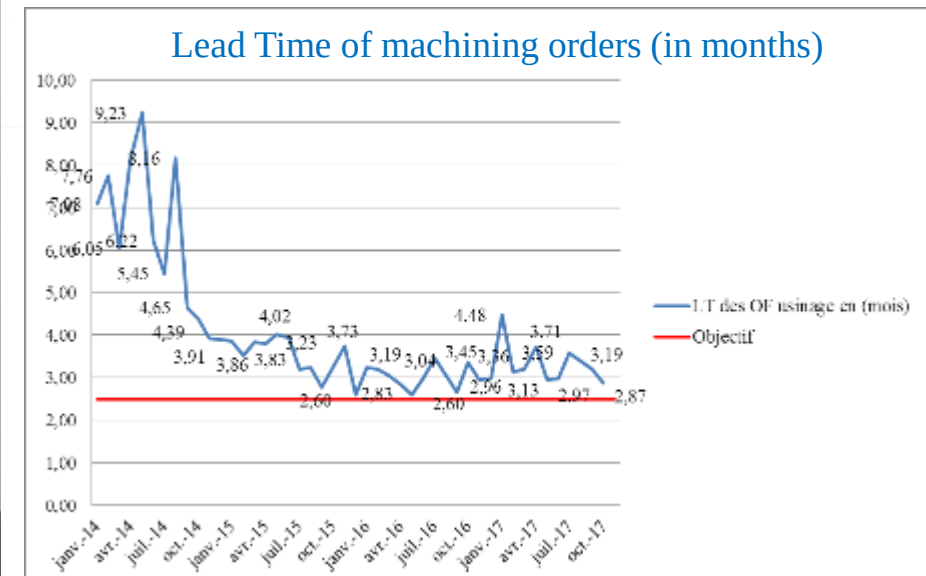
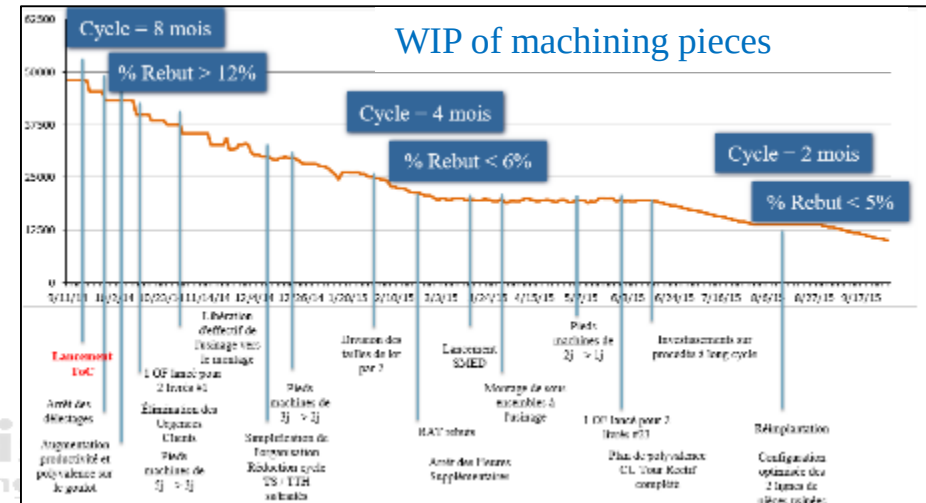
**30% increase in throughput and productivity
in 2 weeks!**
**95% reduction in the number of missing parts
during assembly in a few months!**

Machining pieces late for assembly



... and concrete results were quickly seen (#2/2)

- Increase in TA / TR (Time Allocated over Time Realized) productivity of the Mechanical Unit from 55% to more than 95%.
- Reduction of lead time in manufacturing orders from 9 to 2.8 months.
- The plant won the group's 2016 performance and competitiveness awards.
- The site won the best supplier award from its main customer Airbus.





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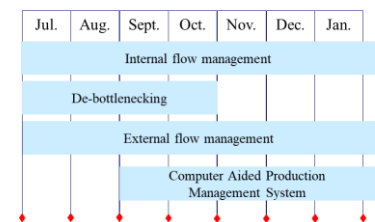


You can boost your improvement process now

- Due to the Covid-19 context, we have transformed all of our services into online services.
- Benefit from our many sessions and exceptional pricing offers.
- Our next free webinars:
 - How to find Bottlenecks in Projects and Productions?:
 - In French, on May 20th
 - In English, on May 27th
- New webinars are being programmed for the coming weeks.
- Our next online training sessions:
 - June 30th to July 3rd : Critical Chain in English (8 hours over 4 days)
 - Critical Chain in French (To be scheduled in June or July 2020)
 - ToC in Production in French or English (To be scheduled in July 2020)
- You can register to our free webinars and our trainings on our website
- “Remote” Diagnosis and action plan



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Thank you for your time

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Questions ?

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Do not hesitate to connect with me on LinkedIn

[linkedin.com/in/philipmarris](https://www.linkedin.com/in/philipmarris)

Linked in.





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Over 300 videos on the Marris Consulting YouTube Channel



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YouTube *Factories, People & Results*

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Video Title	Duration	Views	Age
Theory of Constraints in production	5:06	55 k vues	il y a 3 ans
Theory Of Constraints Crash course	13:30	13 k vues	il y a 2 ans
You are probably wrong about where your capacity constraints are	25:30	10 k vues	il y a 4 ans
Théorie des Contraintes en production	5:32	10 k vues	il y a 7 ans
Critical Chain Project Management	6:01	9,9 k vues	il y a 3 ans
Logical Thinking Process	4:37	1 of 7 - Logical Thinking	
TLS: Good TOC + Good Lean	11:59	TLS: Good TOC + Good Lean	
Règle "2 pour 1"	4:43	Règle "2 pour 1" pour	
Management de Projets	4:51	Management de Projets	
Tutoriel - Planification et	7:00	Tutoriel - Planification et	

Useful web links

To get the latest news about Theory of Constraints

- 5 permanent news website dedicated to Theory of Constraints (www.Scoopit.com)

- Theory of Constraints (French & English)
- Critical Chain (French & English)
- TLS: ToC + Lean + Six Sigma (English)

- >300 Videos (Marris Consulting YouTube Channel)

- Discussion groups (LinkedIn)
 - Critical Chain Project Management
 - Theory of Constraints
 - TLS: ToC, Lean and Six Sigma
 - Logical Thinking Process

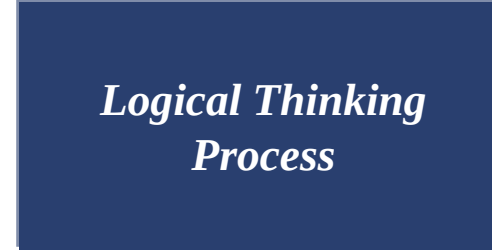
- Others:
 - Twitter, Facebook, etc...





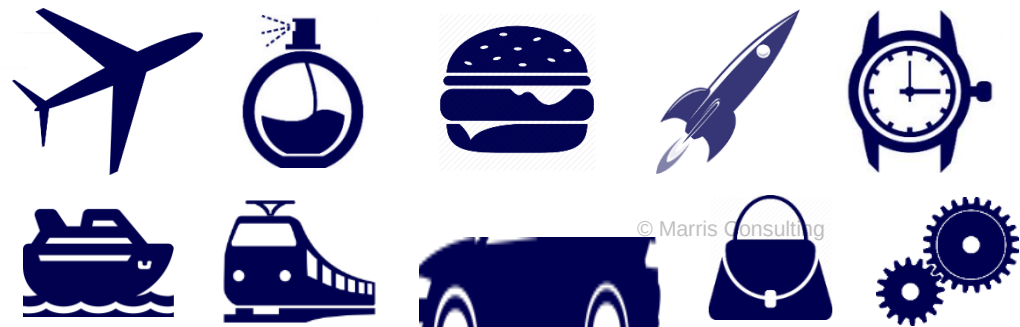



Marris Consulting organizes more than 30 inter and intra-company training session per year



Presentation of Marris Consulting

- Marris Consulting, founded in 2005, is a consulting company specializing in improving the operational performance of companies in the industrial world.
- The approach of Marris Consulting is based on the combination of Theory of Constraints (ToC), - and its various applications including Project Management by the Critical Chain -, and Lean and other Six Sigma type methodologies when it helps our customers' issues.
- Marris Consulting has a reputation for its ability to be pertinent in all kinds of industry. We have worked in over 250 companies helping in designing, making, selling and distributing:
 - cars, hamburgers, airplanes, perfume, trains, rockets, industrial equipment, pharmaceuticals, home delivery services, computer chips, chips (food), maintenance / repair / overhaul (MRO) of planes and trains, luxury handbags, corrugated cardboard production, the defense industry, Swiss watches, steel manufacturing, plastics, bank notes, satellites, gold mines
- We are committed, viscerally, to producing results. Results that are well beyond our clients' expectations. And results that last. Better still, we incessantly seek to strengthen the process of on-going improvement; we want to see our ex-clients getting better and better many years after we intervened.
- Marris Consulting is based in Paris, but operates throughout France, Europe and around the world



How we do it

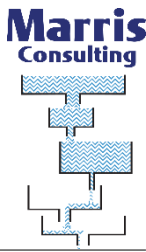
- We understand that the hardest part of what we do is to change "people". In addition to the pertinent ideas we must have, we must directly and indirectly change individual and collective behavior.
- We work simultaneously at all levels of the company from the front line to the board room.
- We are recognized experts in many different fields: "Lean" (manufacturing/engineering/management/...), the Theory of Constraints, Six Sigma, Industry 4.0, DDMRP ...
- One of our key strengths is that we analyze each of our new client's business & culture and then, we mix up the right cocktail of solutions. We never impose a so-called industry best practice.
- We like simple solutions. Simple is beautiful.



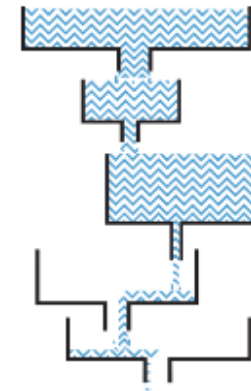
Philip Marris presents the
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