www.tocpractice.com

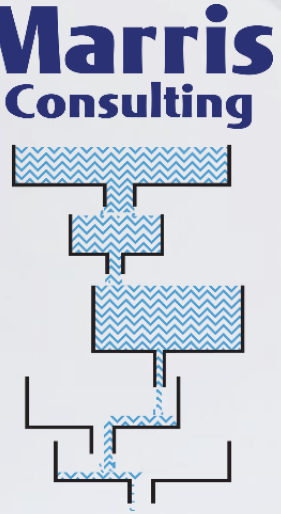
38th TOCPA International Conference

28-30 March 2018, Paris, France

Boosting rocket production using the Theory of Constraints

Christine JAUFFRET

EUROCRYOSPACE, FRANCE



CHRISTINE JAUFFRET

Brief bio

- Engineer diploma in 1986
- MBDA: System engineer,
  then Missile System program manager
- Airbus Defense & Space:
  Head of Tactical UAV Systems programs
- EuroCryospace: Head of programs
  and now, Managing Director

3 children

EuroCryospace: Air Liquide & ArianeGroup company

Business: manufacturing of cryogenic tanks and associated equipment for the Ariane 5 launcher

Customers:

- ArianeGroup
  - Satellites operators

Creation: 1988,

Turnover: ~ 50 M€

Employees: 160 persons

EuroCryospace – Les Mureaux

- Les Mureaux site: 16 000m² inside the ArianeGroup site - Industrial flows and coordination are facilitated by the co-location on the ArianeGroup site

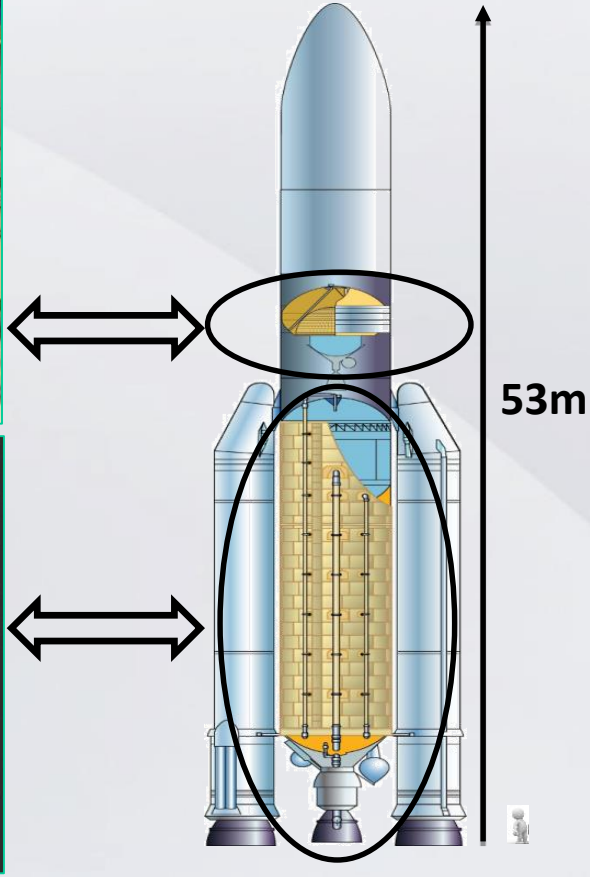
Activity

ESC

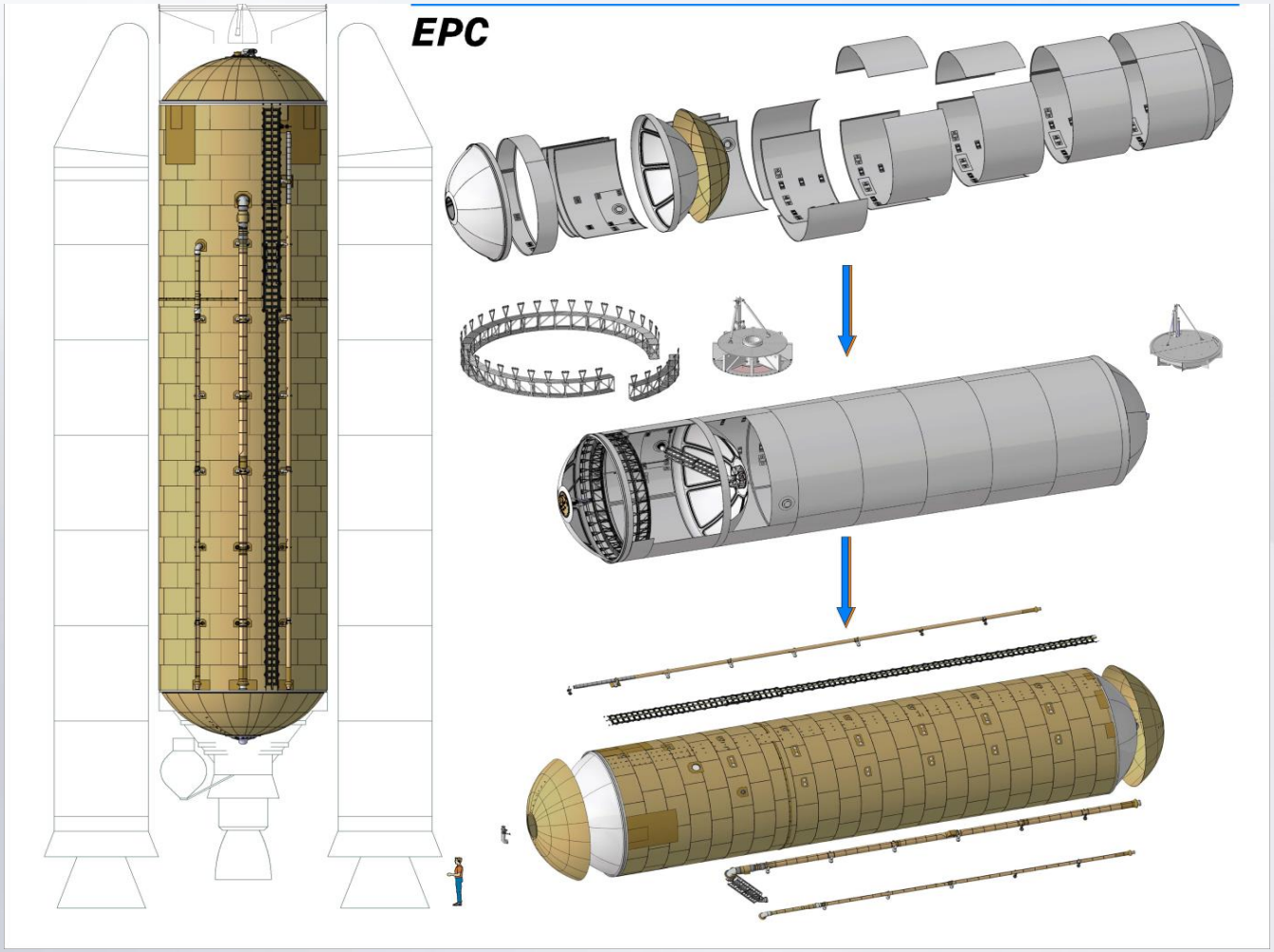
Cryotechnic upper stage H2 tank and lines

EPC

Cryotechnic main stage tank and lines



EPC tank manufacturing process

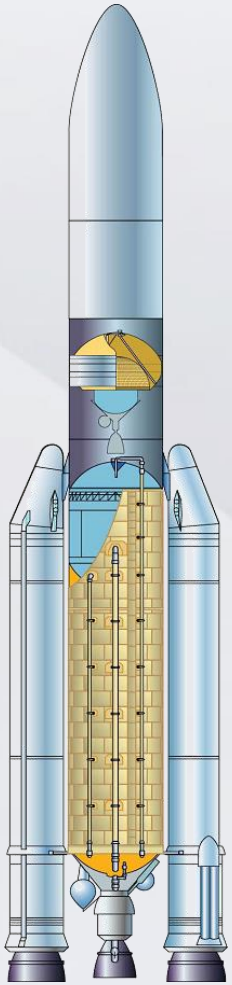


The initial context: not enough rockets

- Necessity to meet the increasing market requirements

A production capacity of 6 to 7 tanks (EPC) per year on average, but around 5 tanks production rate in reality …

… for a demand that has increased to 8 EPC per year



Initial context: major changes in the external and internal context

Before 2014: Leader on the market	▪ 1988 - Creation of Cryospace by Astrium and Air Liquide. ▪ 2012 – Creation of EuroCryospace for the A5ME program with an establishment in Bremen
New competitors	**Space X, China, India, …..**
The answer of Ariane towards competition	▪ 2015 - A5ME shutdown & launch of the A6 program. New business strategy
2015 - 2016 Internal changes	▪ In 2015, EuroCryospace was refocused on Ariane 5 production and support

Continuous Improvement company project > Cryoboost

Reminder:
5 Focusing steps

1. IDENTIFY the system's constraint(s)

   Easy to do in production but not in projects

2. Decide how to EXPLOIT the system's constraint

   Without investments in $ or in time

3. SUBORDINATE everything else to the above decision

   The most difficult step

4. ELEVATE the system's 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's constraint

   Or choose the "best" constraint of the system

Note: Often called *The 5 Focusing Steps* or TOC's *Process Of On-Going Improvement* (POOGI).

Breaking the constraints one after the other

- The bottleneck changed many times during the project because of the improvements made on each successive bottleneck

Bottleneck 1:
Welding machine for the tank

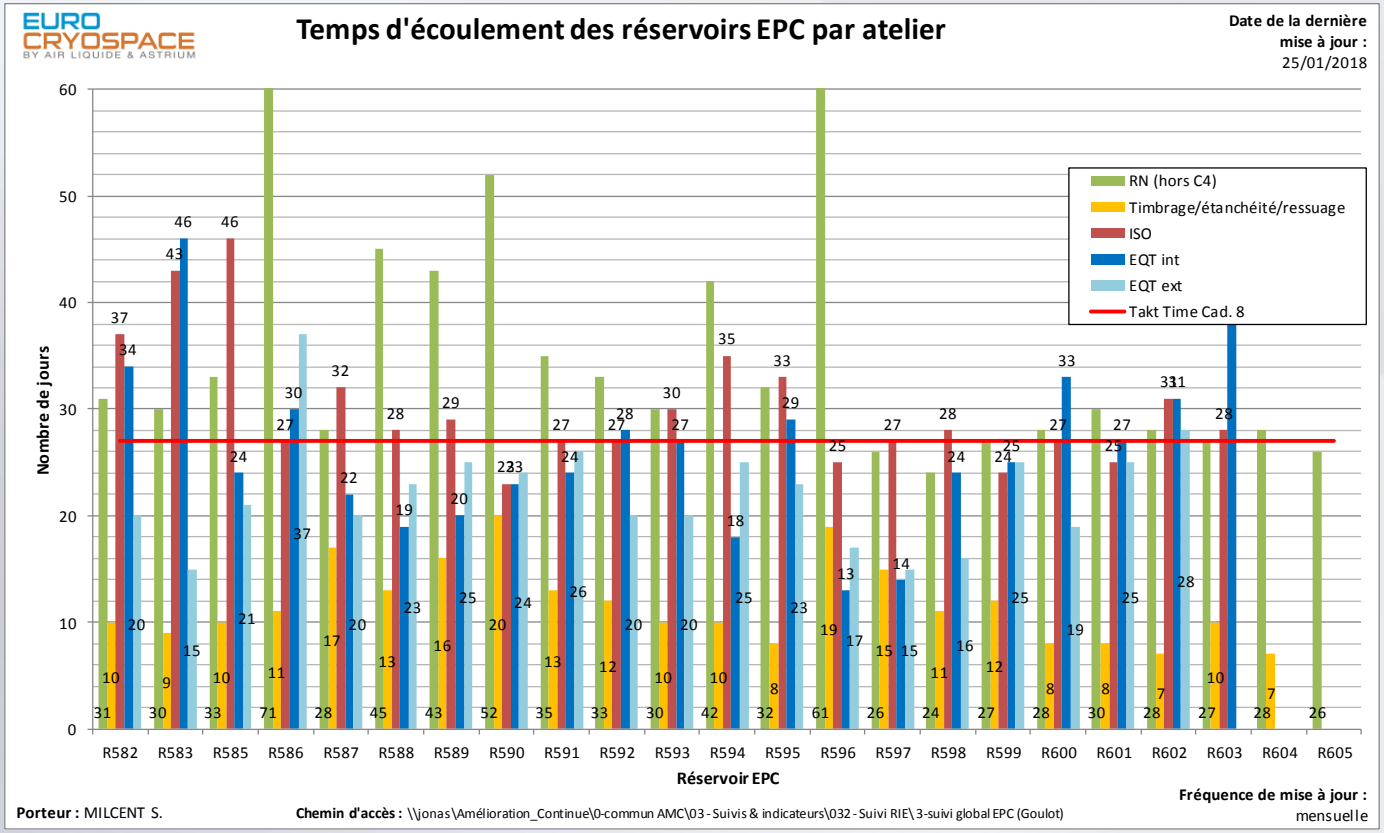
Bottleneck 2:
Incoming quality inspection

Bottleneck 3:

X-Ray control of the lines

Bottleneck 1:
The EPC tank welding machine

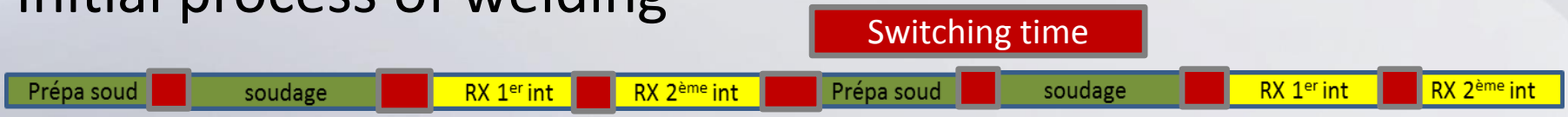
- Welding machine identified as the first bottleneck.
- Takt time around 38 days vs a requested 27 days Takt to deliver 8 ranks / year



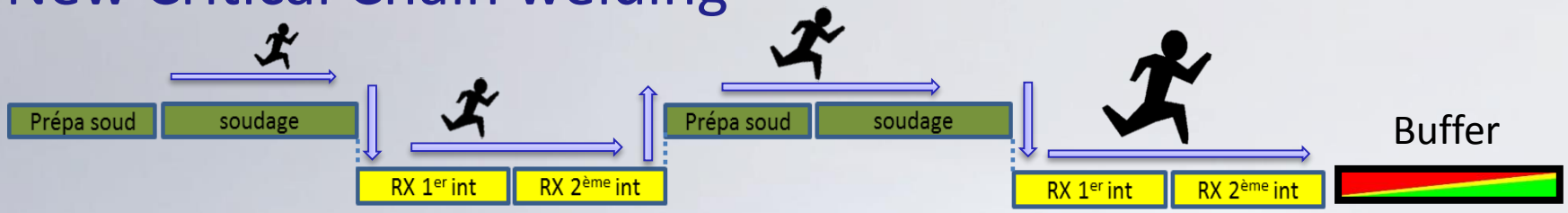
Applying the Critical Chain principles on the welding machine

- Use of a mascot to facilitate the communication and increase efficiency between production and control operations

Initial process of welding

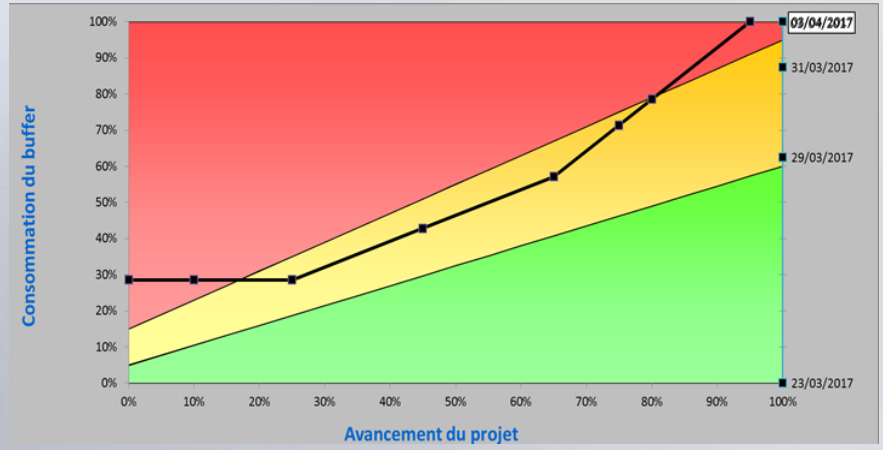


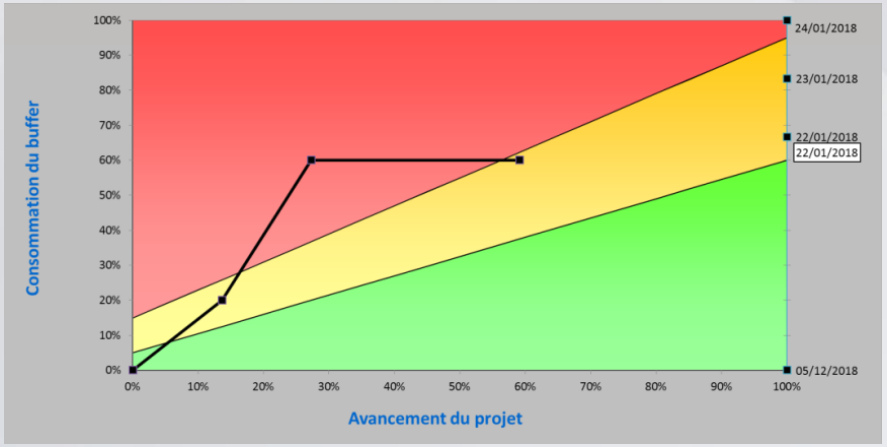
New Critical Chain welding



Critical Chain + Lean
To improve performances

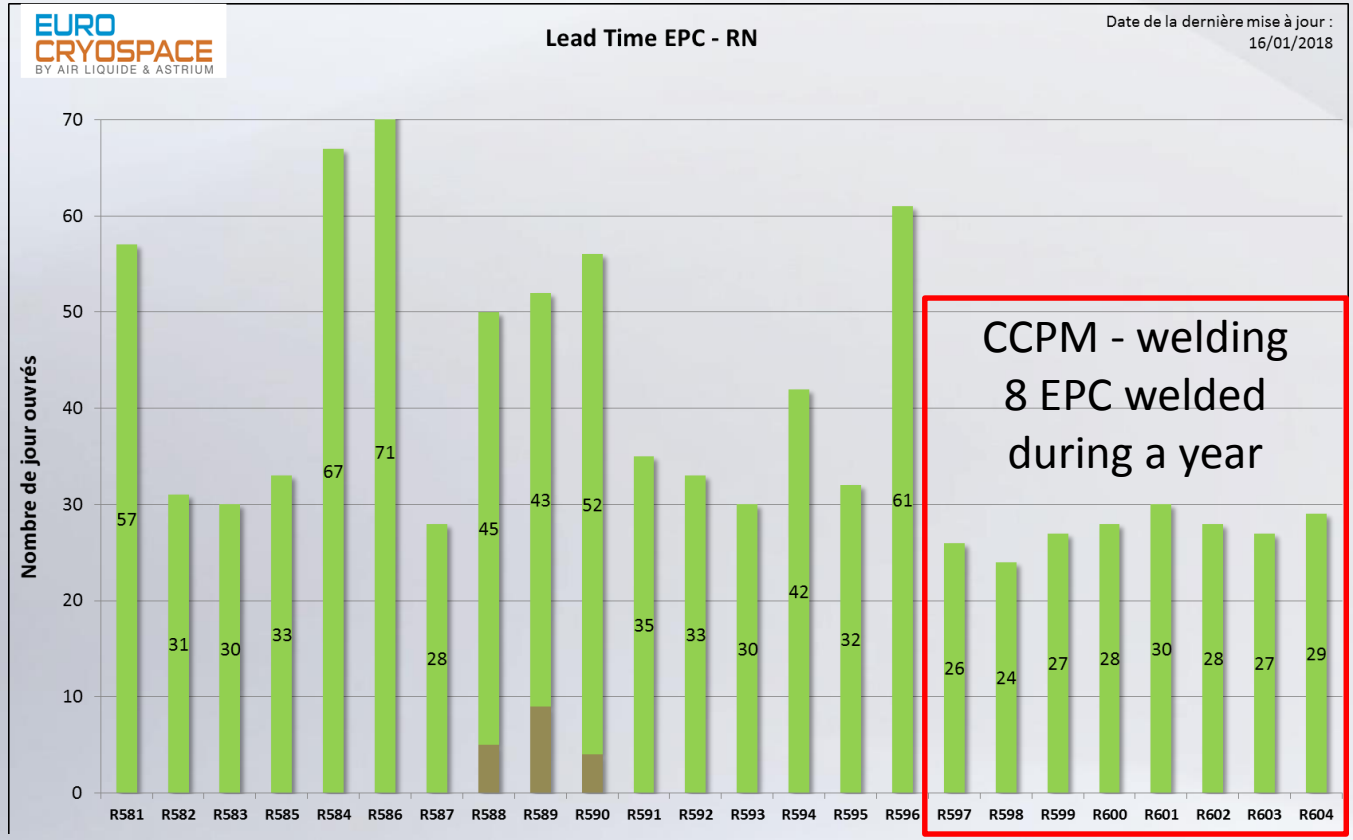
- First step: a workshop observation in order to analyse the real "focused duration" of each task
- Second step: the planning of operations was reduced from 38 days to 27 days (22 days + 5 days of buffer)
- Tanks schedule execution monitored with a Fever Chart





Results: a huge increase in speed and productivity

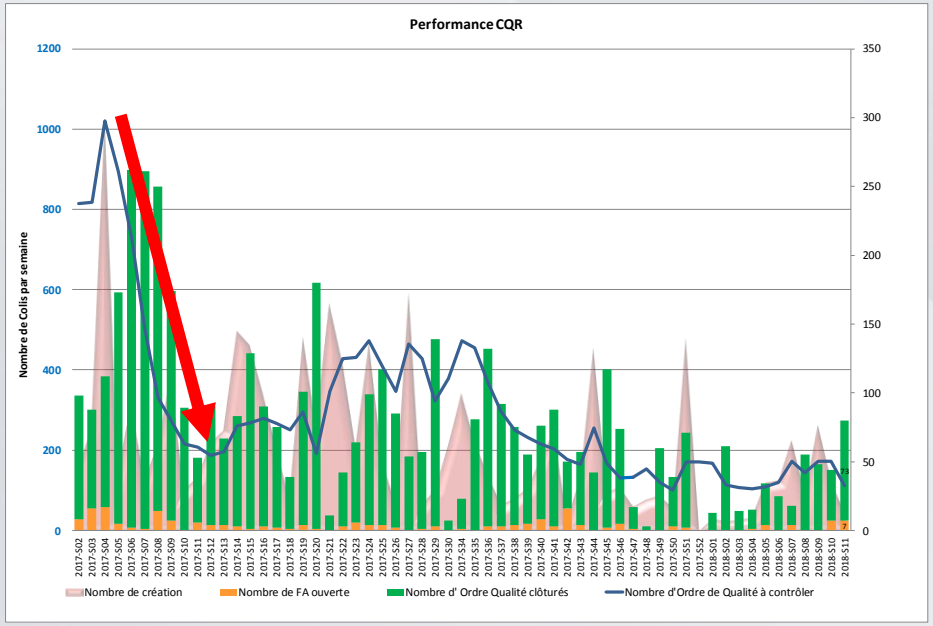
- Welding machine Takt Time reduced from **38 days in 3 shifts** to **27-28 days in 2 shifts**



Bottleneck 2: Incoming Quality Inspection

- The work-in-progress in the inspection area went from 1000 packages (Quality Orders) to less than 200 in 6 weeks
- To absorb the WIP in the incoming quality inspection area

  - The “2 for 1” rule to reveal excess capacity on non-bottleneck resources and work on versatility of operators
  - Reassign inspectors from other under loaded sectors (non-bottlenecks)
  - 3 people per typology and per batch, gain in autonomy & efficiency, …

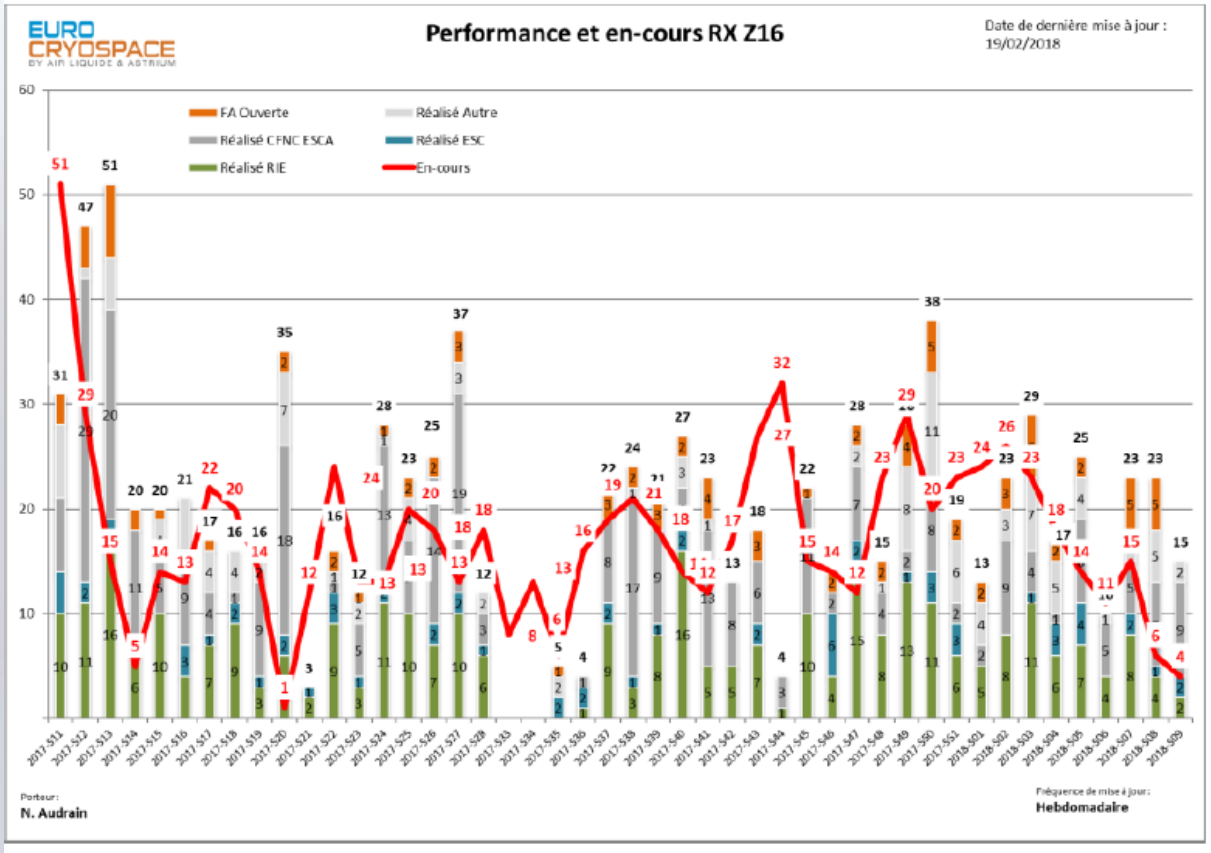


→ The WIP reduction has reduced the stress level of the team

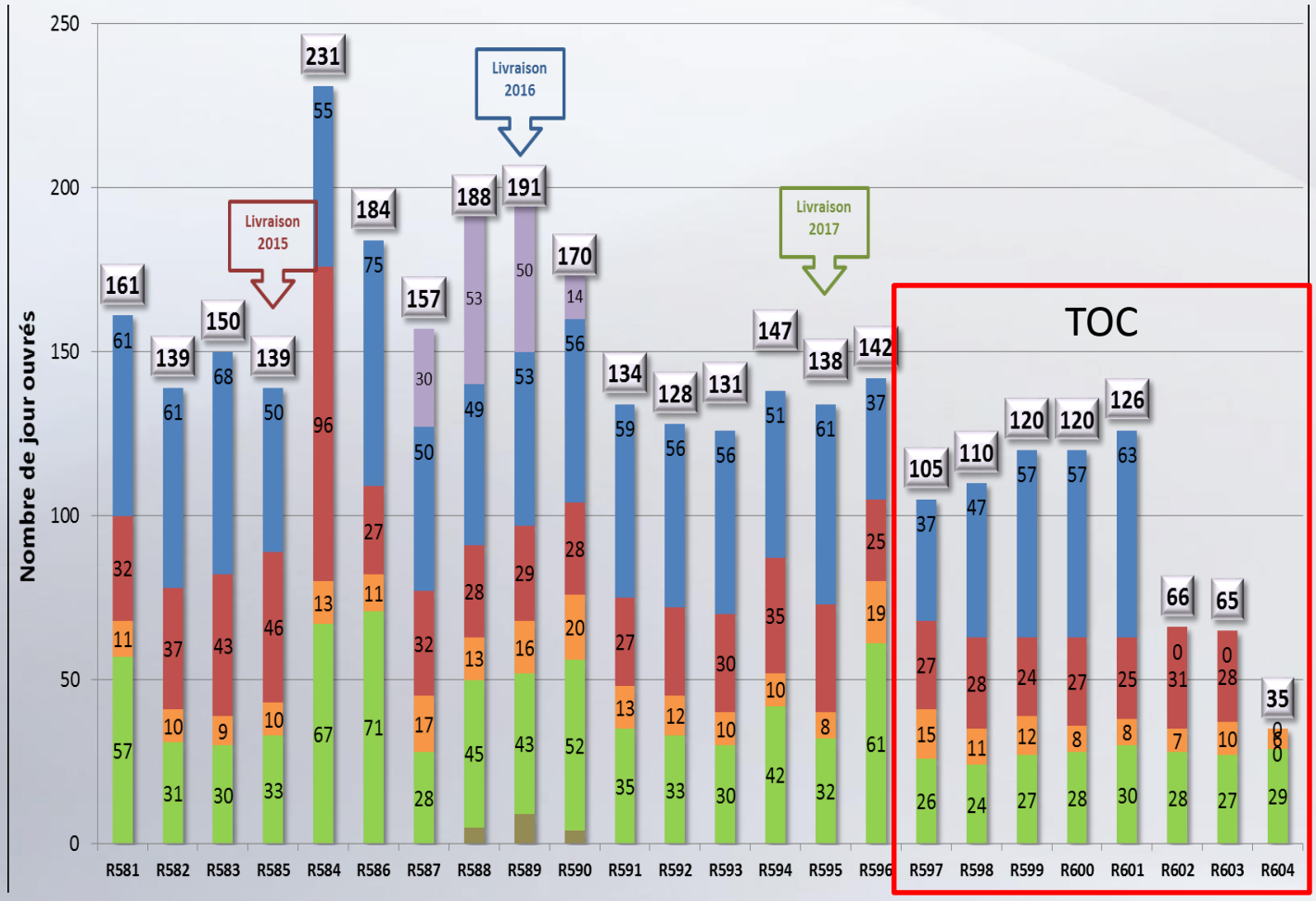
Bottleneck 3: X-Ray control of the lines

- 130 lines in progress in the workshop
  → 50 waiting for the X-Ray control

- Necessity to add extra capacity when needed (from other departments)
- Schedule of the work in progress in front of this bottleneck in order to maximize its productivity



Throughput increased by 25%



Throughput 2016:

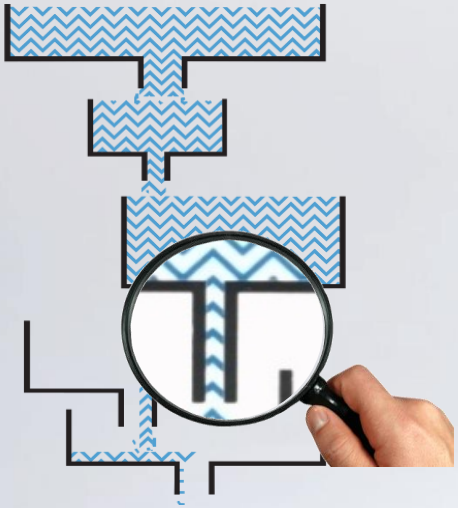
6	6	8

Throughput 2017:

6	7,5	8

Conclusion

- Significant increase in performance obtained by focusing on some manufacturing operations, thanks to the Theory of Constraints combined with Lean actions
- Results obtained in a few months
- Throughput of the tanks increased by 25 %



Any Questions ?