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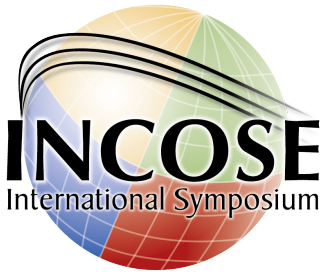


# INCOSE 2012
## Rework: Model & Metrics

**Edmond TONNELLIER & Olivier TERRIEN**
Thales Systèmes Aéroportés (TSA)

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# Where?






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# TSA: core businesses

Unmanned Air Vehicle systems

Sensors, sensor systems, for combat platforms

Maritime Patrol & Surveillance systems

Fighter aircraft retrofit

Self-protection systems

**N°1 in Europe**

**cutting-edge technologies**

**from research to manufacturing**

**~20% of revenues dedicated to R&T**

*TSA: Thales Systèmes Aéroportés*

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# TSA: locations

## ~3000 people in:

- Elancourt (headquarters)
- Brest
- Pessac

## In close collaboration with:

- Crawley & Leicester – Thales UK
- Etrelles – Thales Microelectronics
- Orsay & Ulm – UMS (JV Thales & EADS)


*TSA: Thales Systèmes Aéroportés*

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# Why?






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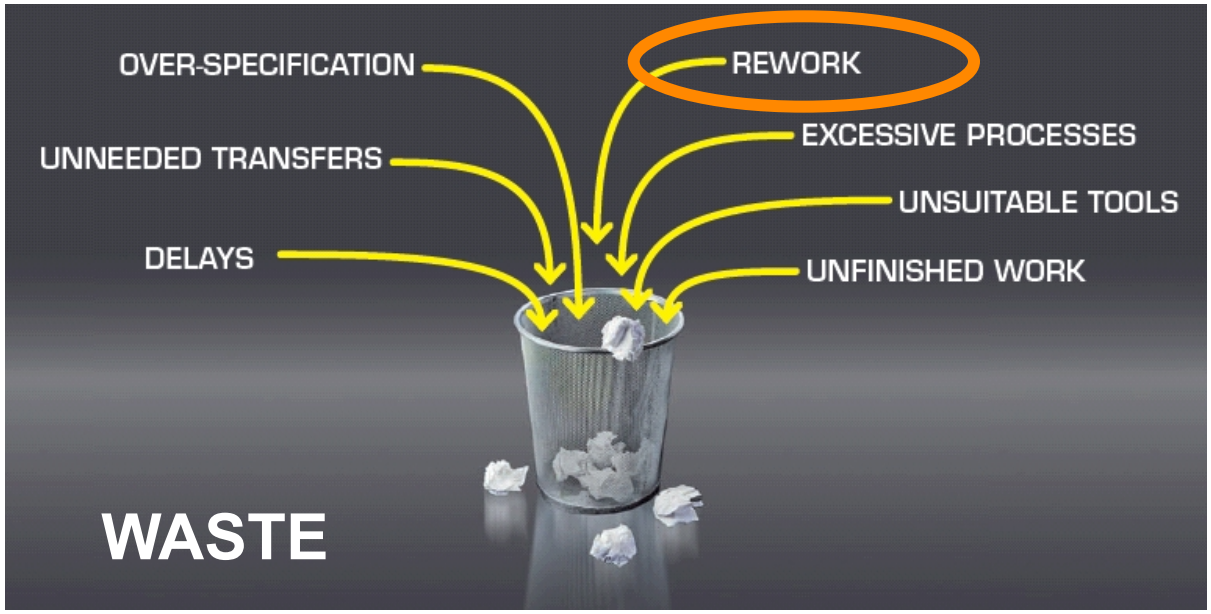
# Stakes & Issues

"why has our schedule been delayed?"

"what caused this extra cost at the end of our project X?"

"how can we explain this cost shift on our project Y?"




*Poster CSDM2010*

**After several benchmarks, we have turned our first corner and started an initiative on rework**



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# Definition of Rework

**Rework: "work done to correct defects"**

**Defect: "failure to conform to requirement"**

**(even if this requirement has not been explicitly specified)**

*Definitions from P.Crosby, 'Quality is Free'.*

"Incomplete or misinterpreted requirements at the start of a project resulting in rework in cascade through to subcontractors"

"Low defined designs result in expensive reworks to meet the customers' true requirement".

"Late changes in requirements cause high levels of rework throughout the life cycle of products"

*Examples from external and internal interviews (benchmarks).*

**How can we keep inevitable rework under control?**



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# What?



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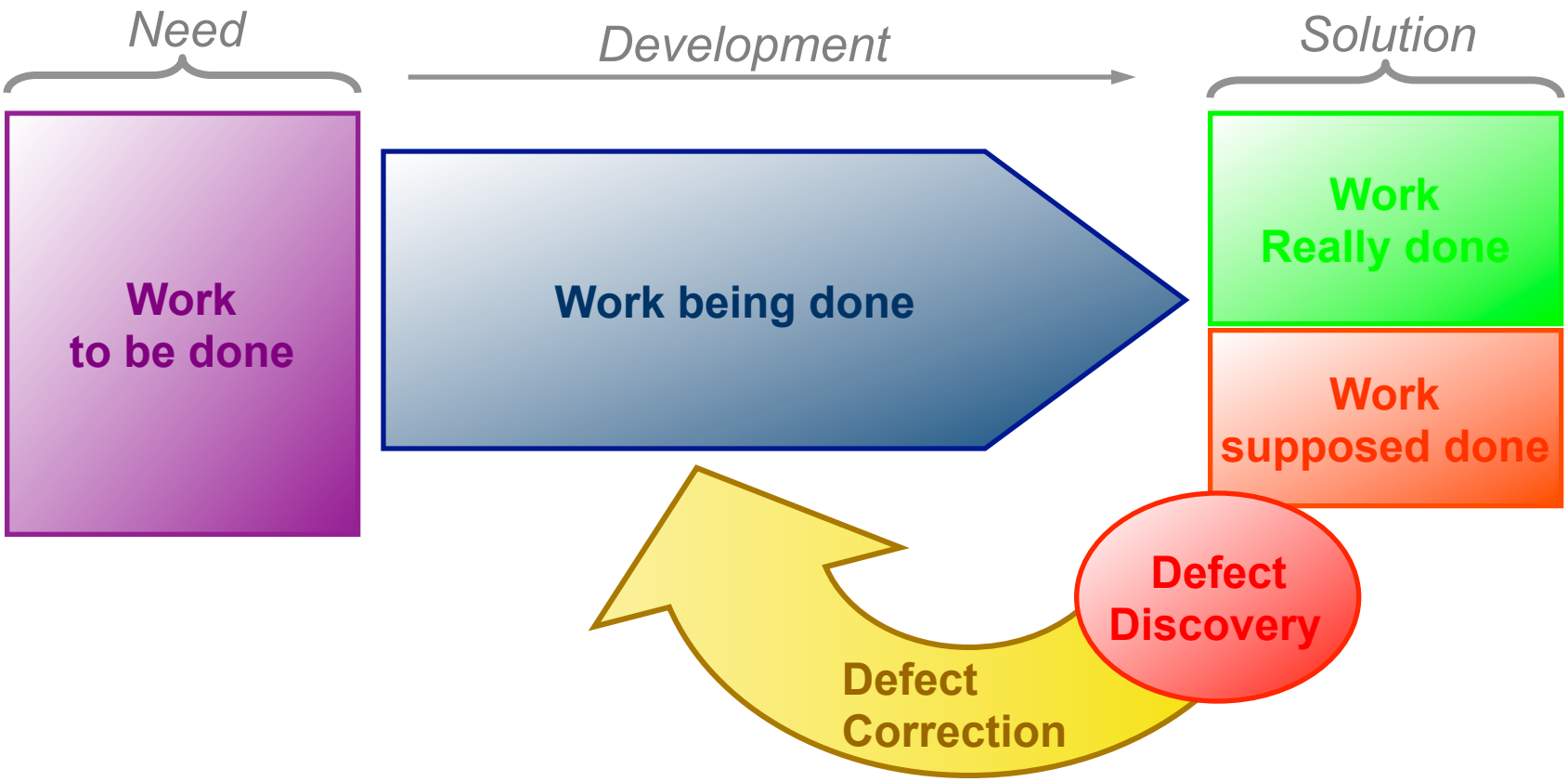
# Behavioural model




**'Re-work' is a looped phenomenon on solutions and/or processes**



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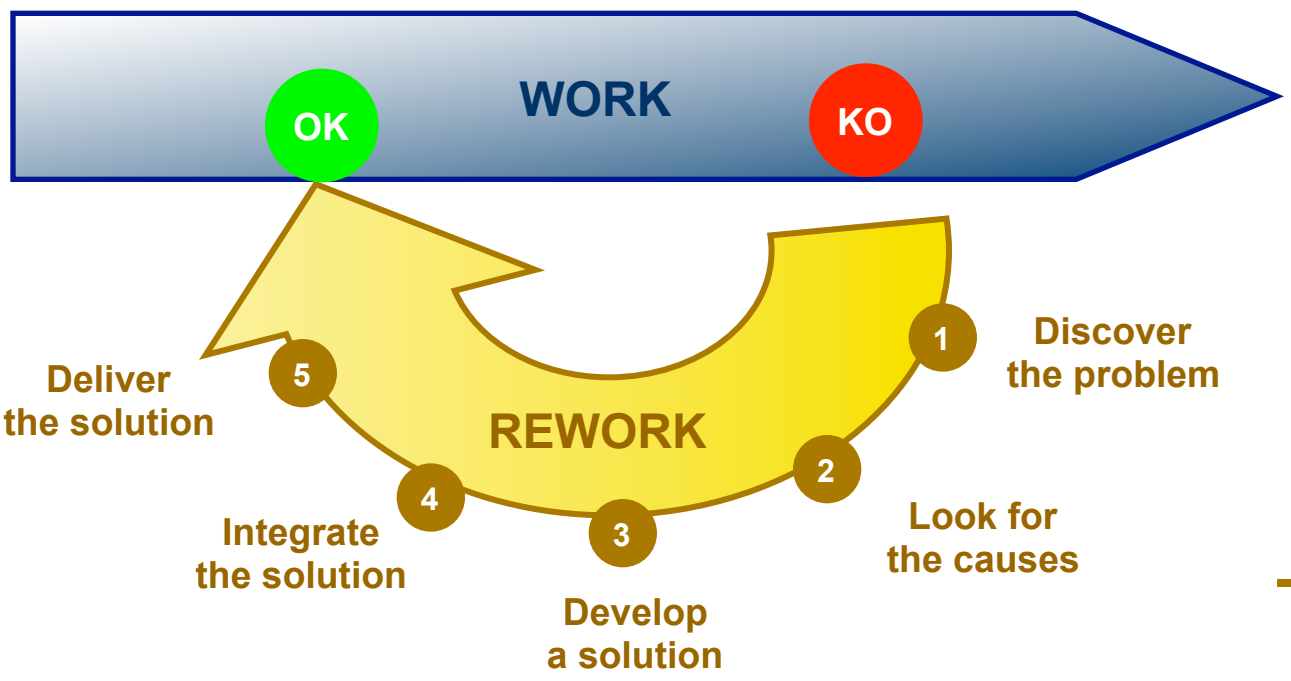
# Model of a looped phenomenon




1 + 2 + 3 + 4 + 5

+ Monitoring

= REWORK

**Rework plays a central role in generating delays and overcosts**

*KO means 'not OK'*



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# How much?






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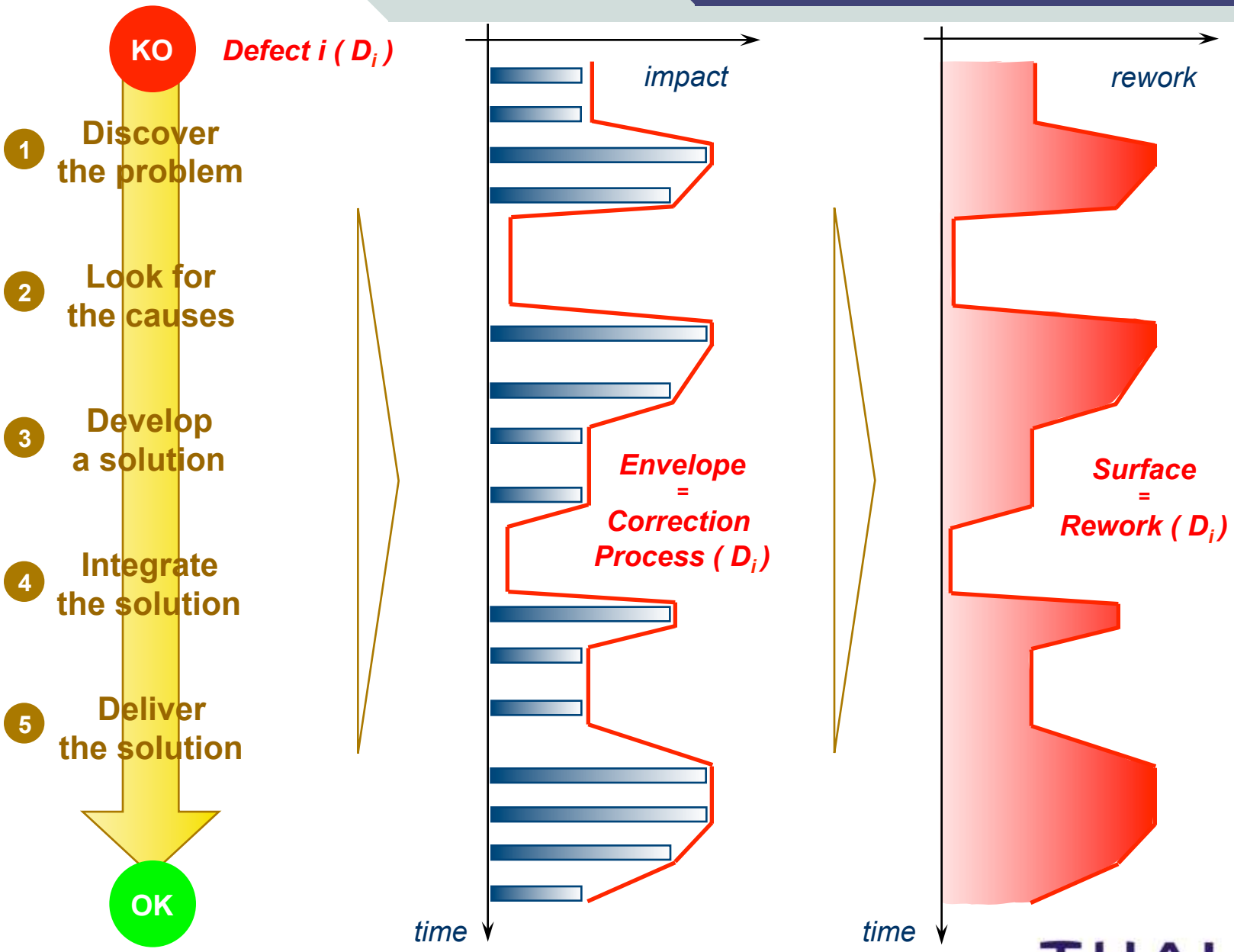
# Impacts on extra-delays and over-costs



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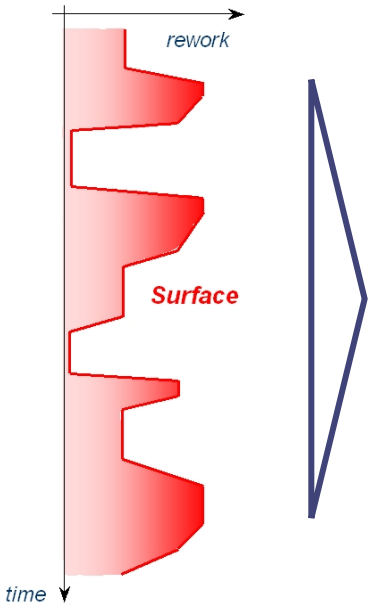
# Mathematical model




$$\text{Rework}(D_i) = \int_{t_{start}}^{t_{stop}} CP(D_i, t)\,.\,dt$$

$D_i$ : Defect i

$t_{start}$ : date of detection of the defect i

CP : Correction Process

$t_{stop}$ : date of closure of the correction process

**'Re-work' is an accumulation of over-activities to correct defects**



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# How?

**Following graphs and figures are extracted from training materials**






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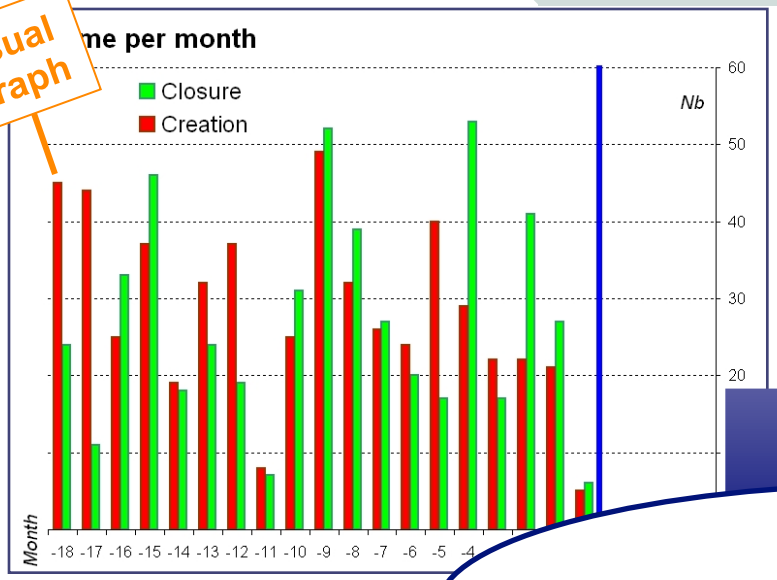
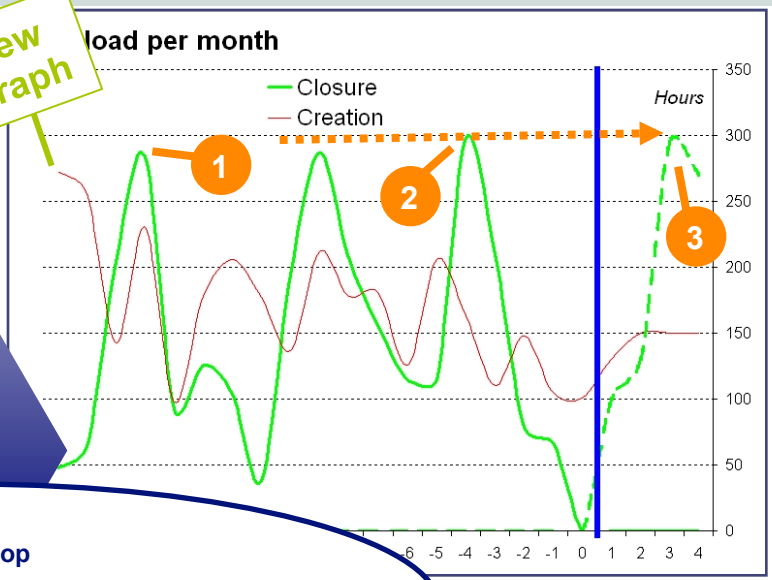
# Lever 1 : “volume per month”

Usual Graph




New Graph




$$\text{Rework}_{\text{Hours}}(D_i) = \int_{t_{start}}^{t_{stop}} \text{CP}_{\text{Hours}}(D_i, t)\,.\,dt$$

Prediction

## Volume of defects per month:

Sorted by date (creation/closure), usual graphs display only volumes.

## Workload per month:

Using hours spent to correct defects, graphs display workloads.

1. To identify major events
2. To detect saturation
3. To predict future deliveries



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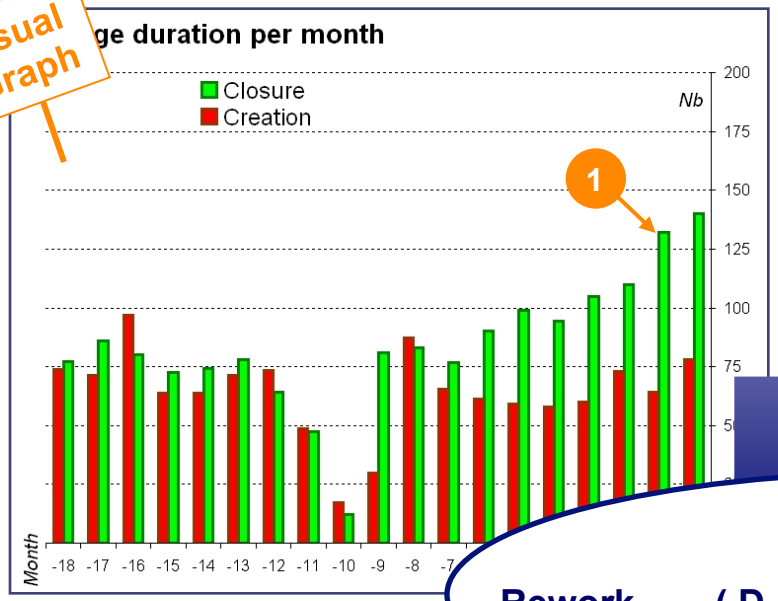
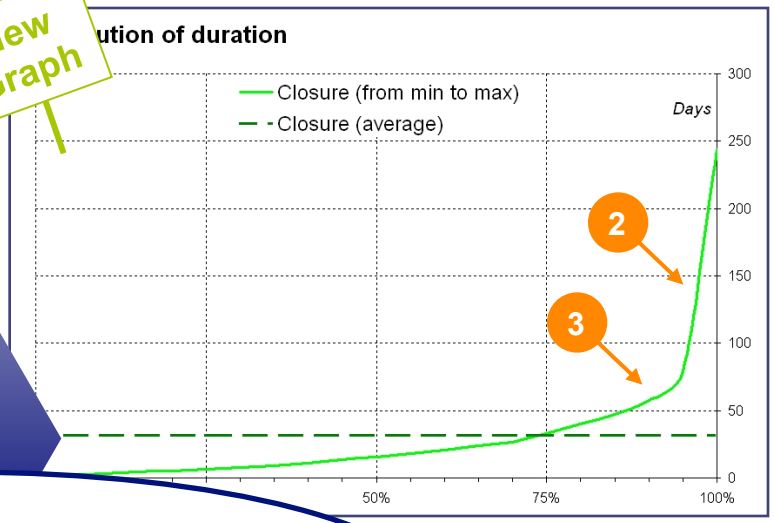
# Lever 2 : “duration per defect”

Usual Graph




New Graph




5%

$$\text{Rework}_{\text{Days}}(D_i) = \int_{t_{start}}^{t_{stop}} CP_{\text{Days}}(D_i, t)\,.\,dt$$

## Duration per month:

Sorted by date (creation/closure), usual graphs display average duration

1. To detect increasing delays

## Distribution per defect:

Distributed by correction processes, graphs display the most disturbing defects

2. To estimate the worst cases
3. To prioritize improvement actions



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# When?



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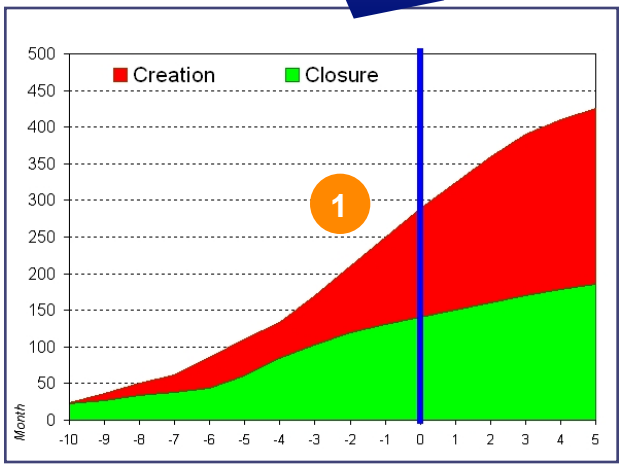
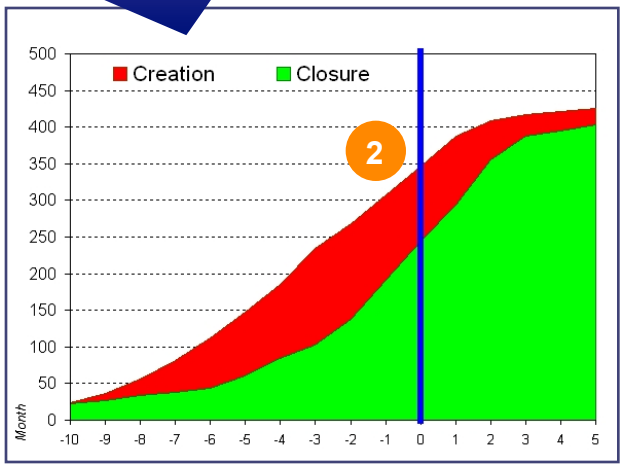
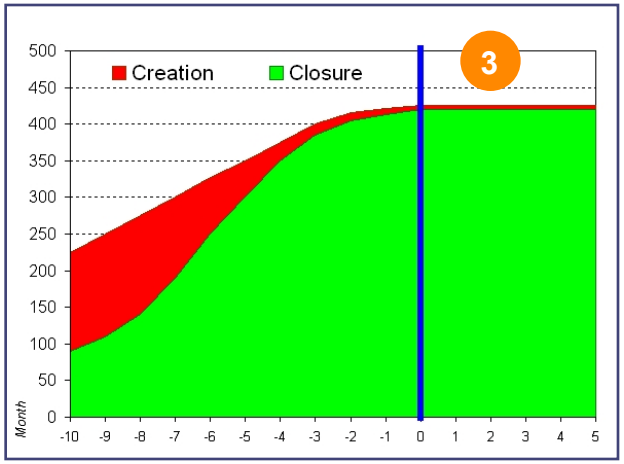
# Lever 3 : "accumulation of workload"

$$\text{Rework}(1, n) = \sum_{i=1}^{i=n} \text{Rework}(D_i)$$

## Typical S-curves on projects




**Divergent curves:**
Increasing rework,
1 → project not under control ('firemen syndrom')

**Convergent curves:**
Increasing rework,
2 → But project under control

**Never-ending curves:**
Rework is like a 'tail of comet'
3 → End of a project



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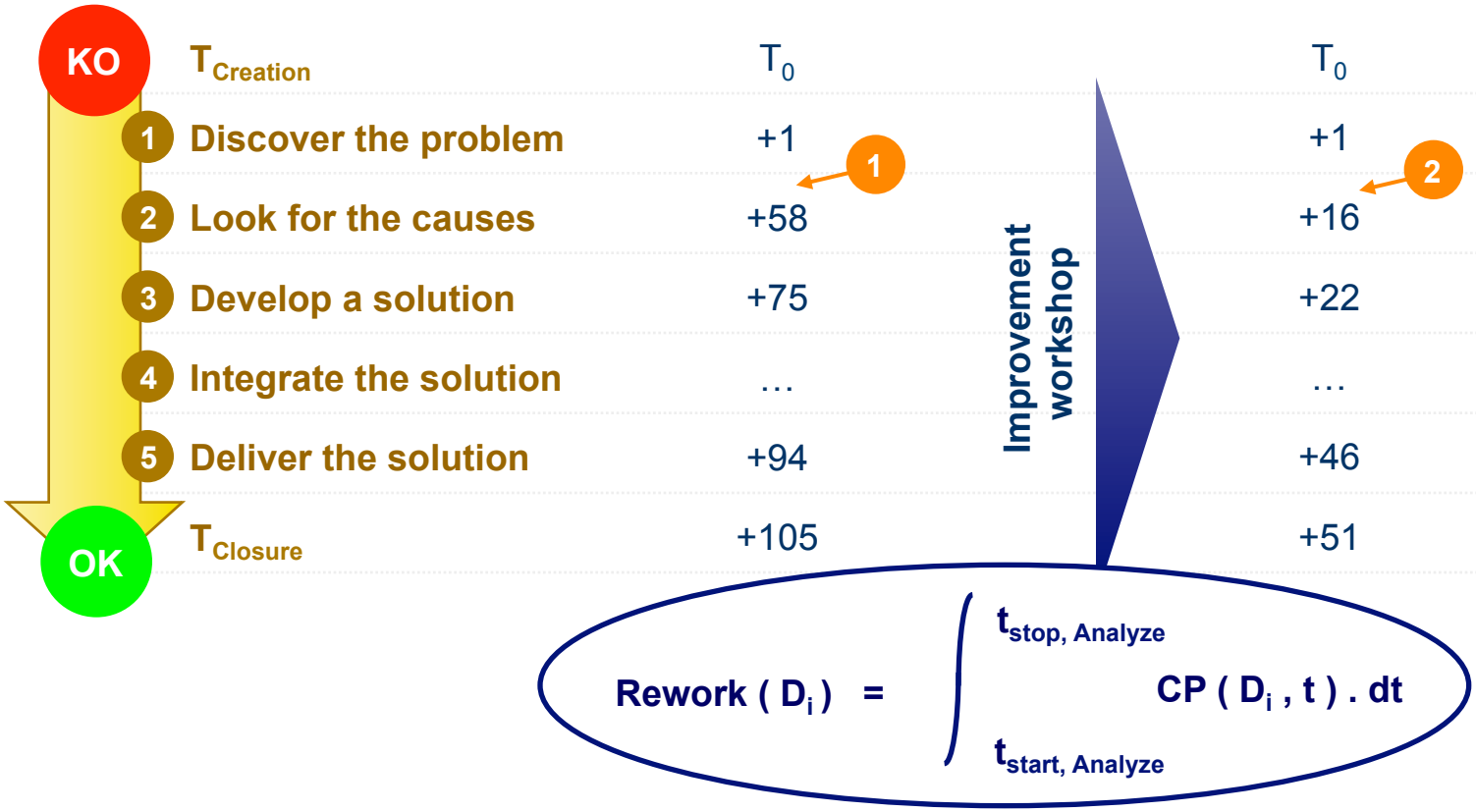
# Lever 4 : "levers per step"




## Map the current situation:

Describe and quantify the current correction processes performed by local teams

1 Identify possible improvements

## Evaluate improved situation:

Quantify the correction processes performed by local teams after improvement actions

2 Check achievements



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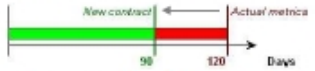
# Lever 5: "Make waste visible"

## 'Reduction of Change Request Processes'

| Date: Jan.2011 | Owner: S.B. | Coach: O.T. | Supervisor: E.T. | TSA1000687-03 Mar.2011 |
|---|---|---|---|---|

### Context

**Stakes:** Every week the IXLR8 team updates its metrics about Change Requests (CR: process to correct detected defects). At the end of 2010, the average duration of CR was 120 days (delta average between the date of closure and the date of creation). In March 2011, a contract for developing a new airborne electronic product specifies a maximum average of 90 days.



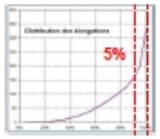

**Objectives:** To accommodate this new commitment, the team must reduce the average delay of defect correction by 25%. To ensure a balanced cost / time during CR processes, the team manager requires an improvement of customer commitment notation (+ 2 pts).

### Situation

**Levers:** A macroscopic mapping of the CR process describes the typical sequence of steps to correct defects and quantifies delays between steps with the use of CR databases records.

| CR process: | Detect | > Create | > Analyse | > Decide | > Implement | > Close |
|---|---|---|---|---|---|---|
| 80% of CR (days): | To | + 0 | + 58 | + 75 | + 94 | + 105 |
| Average of CR (days): | To | + 4 | + 63 | + 80 | + 100 | + 120 |

- Important wait between analysis reviews
  - ► increase the reactivity of analysis / decisions
- Lack of critical contributors at the moment of review (analysis / monitoring)
  - ► identify priorities and roles needed for each review
- Derive of administrative tasks
  - ► Get the delay of the administration steps under control



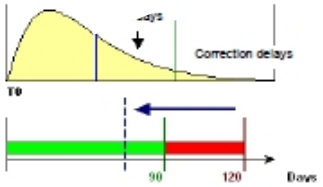

- 15% of CR account for 50% of the average CR
- 5% of CR exceeds the normal life cycle of produc… IXLR8 team

### Target

**Targets:** In order to comply with the clause of a 90 day average, the IXLR8 team in… …s in its metrics.

1) an alert threshold (called "reasonable delay") below which 80% of CR can reasonably be closed (80% of CR < threshold1)

2) a anomaly threshold (called "redibitoire delay") at which the processing time of the CR exceeds the normal life cycle of the product (100% of CR < threshold2).




### Analysis

**Causes:** The IXLR8 team establishes various cause-effect diagrams on the local implementation of the CR process and on the root-causes of technical defects detected during previous developments.

### Counter-measures

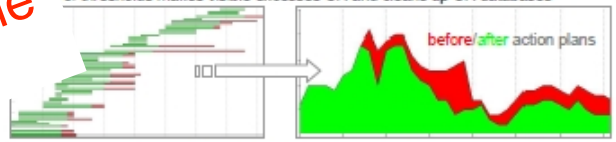
| A | Reduce the volume of CR databases (in progress = non closed CR) |
|---|---|
| A.1 | Determine the X% of CR to close to achieve 80 days on average ("the most penalizing CR") |
| A.2 | Set up a Task Force to close the most penalizing CR (X%) |
| A.3 | Arrange a regular meeting with the customer to systematically close the CR whose time exceeds the normal life cycle of products developed by the IXLR8 team |
| A.4 | Reduce usual time between two periodical reviews of problem/ of CR analysis (from 1 per month to 1 per week but reviews limited to 2 hours max.) |

| B | Involve all the contributors in the CR process |
|---|---|
| B.1 | Communicate the terms of the contract relating to CR ( < 90 day average) to the IXLR8 team |
| B.2 | Make the team managers aware of the regular waitings in the process (and the contractual impacts) |
| B.3 | Train the IXLR8 team at the CR process (training given/relayed by the CR coordinators) |
| B.4 | Display the list of contacts in the CR process (coordinators, managers ...) and next dates of CR reviews |

| C | Sustain the implementation of a quick CR process |
|---|---|
| C.1 | Set up an automatic threshold: alert if the duration of CR exceeds the threshold1: 80% of CR |
| C.2 | Display CRs "on alert" on the board of the team room |
| C.3 | Set up an automatic threshold: anomaly if the duration of CR exceeds the threshold2: 100% of CR |
| C.4 | Set-up a coordinator meeting for the CRs "in anomaly" within 2 days after occurrence of an anomaly |
| C.5 | Set up a regular meetings between the CR coordinators (CR network) to share best practices for resolving Change Requests |

### Results

**Actions:** The … of thresholds makes visible excesses CR and cleans up CR databases




**Control:** By confirming the macroscopic mapping of the CR process, the IXLR8 team completes its monitoring metrics by defined thresholds (alert & anomaly).

| CR process: | Detect | > Create | > Analyse | > Decide | > Implement | > Close |
|---|---|---|---|---|---|---|
| 80% of CR (days): | To | + 0 | + 16 | + 22 | + 56 | + 70 |
| Average of CR (days): | To | + 1 | + 34 | + 48 | + 84 | + 88 |

regular check

The average achieved by the IXLR8 team is 88 days (with 6 days of improvements still possible).

### Feedback

**Data:** Available records from CR databases were sufficient to quantify the action plans of the improvement workshop
The workshop has defined its own priorities on actions to ensure a strategy in implementation
The simulation of possible gains with real data has united the team efforts with efficient enablers

**Training:** Training can not be the only way to improve a CR process (which is a collective work).
The workshop served as self-learning to participants by solving problems in teams, sharing views and defining contributions, etc ...
Communication during the workshop has attracted the attention of the rest of the IXLR8 team (not only the selected participants involved in CR processes).

**Metrics:** The implementation of progressive alert/anomaly thresholds prevents growing durations of CR (acceleration of CR processes and improvement of CR maturity)

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pedagogical example
A3 format






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# Who?






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# Everybody can be concerned…

**Rework is not bad luck but a risk to manage.**

**Now, inevitable rework has become predictable!**






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# Q&A






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