FROM FAILURE ANALISYS TO RELIABILITY IN SUGAR MILLS

- Some analyzed Events
- Common problems
- Maintenance Structure considerations

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Overview

- Introduction
- Failure common aspects review
- New Focus
- RCM & FMECA
- Projections

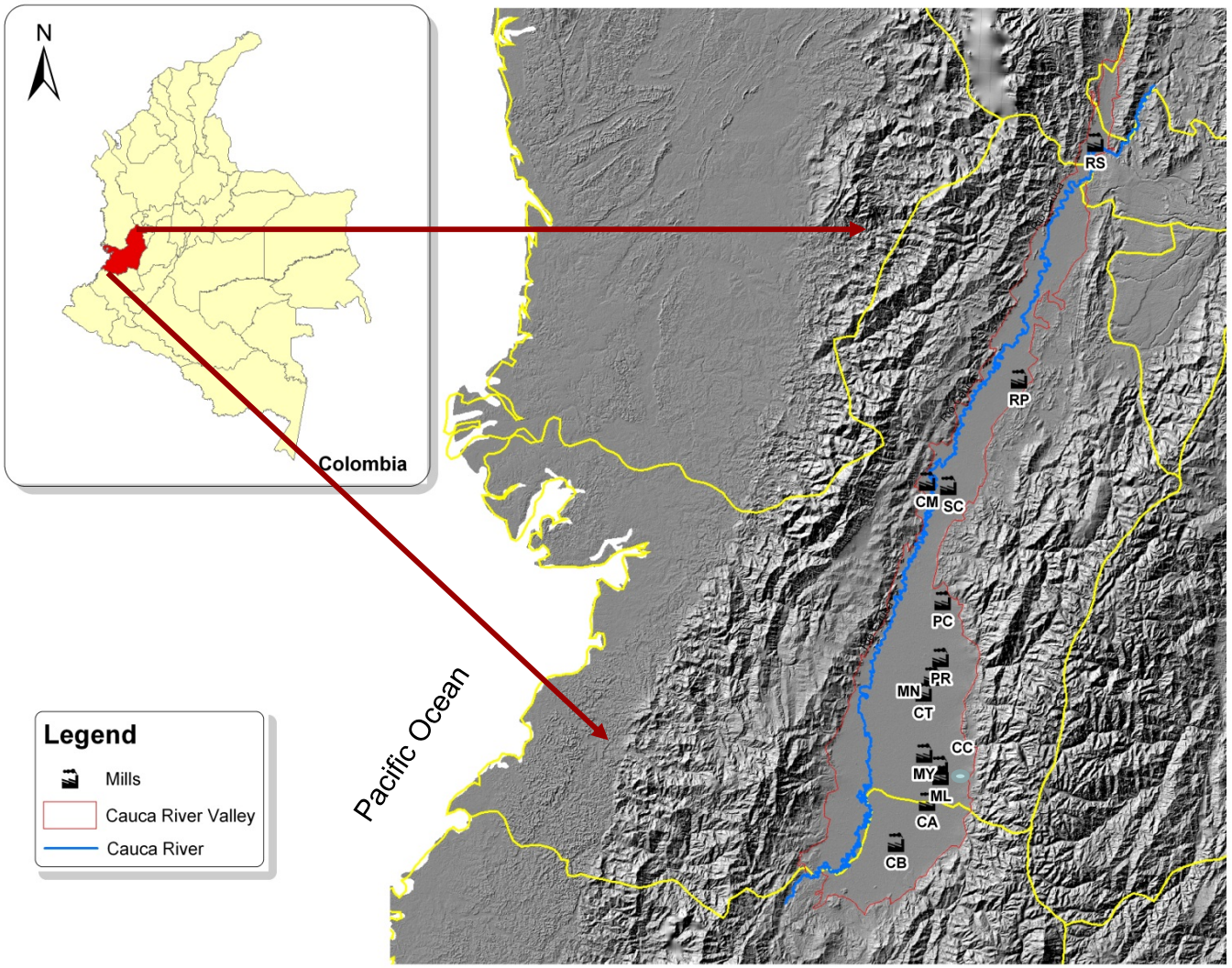
CENICAÑA, the Sugarcane Research Center of Colombia.

- Cenicaña carries out research programs on Varieties, Agronomy and Factory Processes.
- It has support services in Economic and Statistical Analyses, Information and Documentation, Computer Technology, Technical Cooperation and Technology Transfer.
- It provides services of lab analyses, administers the stations of the Automated Weather Network's (AWN), and continually updates the digital cartography of the cultivated area.





Geographic location of sugar mills





- Total Sugar cane area:
  - **215.000 Ha.**
- 13 sugar mills :
  - 5 refineries
  - 6 ethanol plants
  - 10 cogenerators

Colombian Sugar Industry Main Indexes 2013 Season

Crushed cane (t): **21´374.196**

Sugar production (t):**2´339.988**

Ethanol production (m^3):**387.854**

Sugar yield (99, 7% pol): **11,63**

Extraction pol % pol in cane: **95,65**

Boiling House Recovery efficiency, %: **91,5**

Overall Recovery Efficiency, %: **87,5**

Power Installed: **187 MW**

Introduction

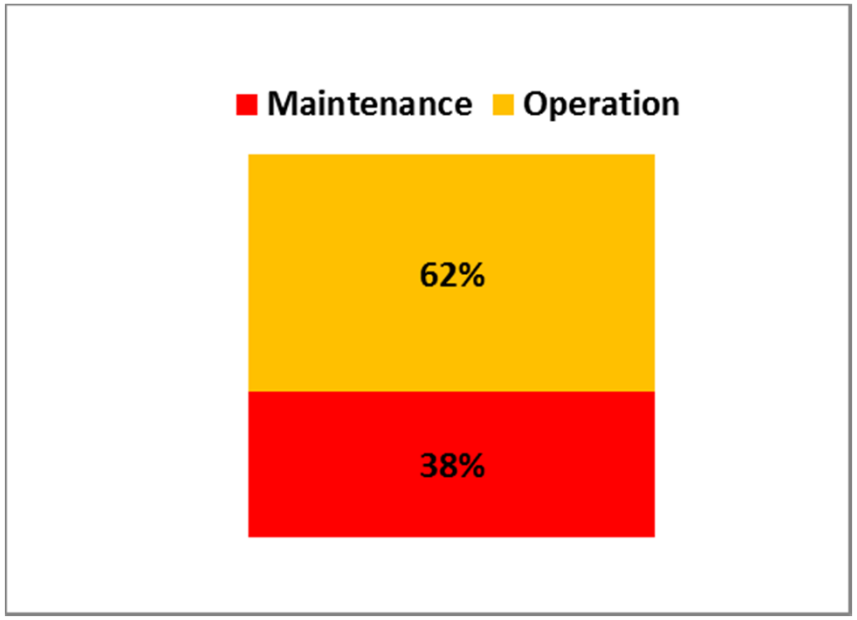
- Colombian sugar mills can crush cane almost all year (average of thirteen mills **297** days for 2013).
- Some mills have a 330 day target. It means that less time is available for maintenance activities.
- It is required to adopt/adapt world class maintenance management practices which allow achieving the production goals in a sustainable way.
- Cenicaña (Colombian Sugar Cane Research Center) has recently begun a new project about Maintenance Management. To propose the characteristics of a World Class Maintenance Management System that impact favorably the principal industry KPI's, is the main objective.

The focus…

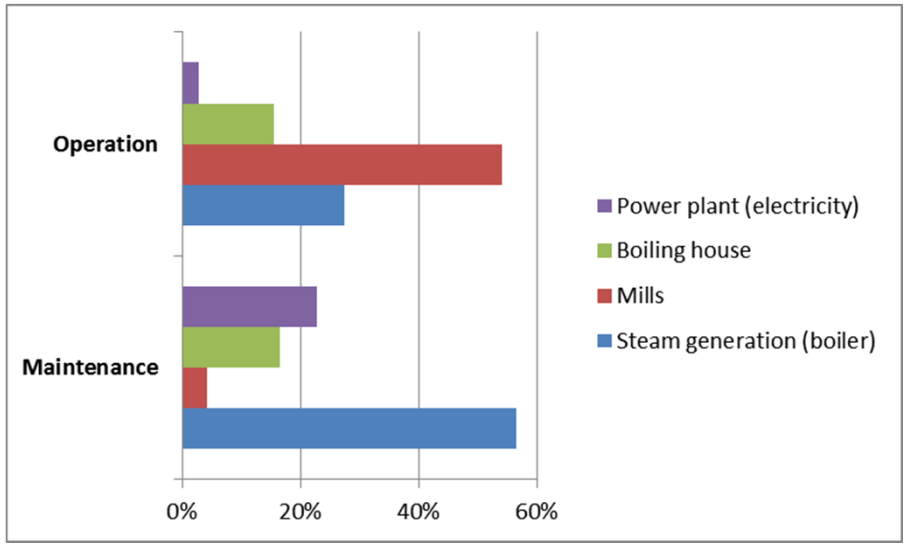
- **RCA** (Root Causes Analysis) is progressively under adoption.
- **RCM** (Reliability Centered Maintenance) is the system adopted by the bigger factories
- Some failure events show:
  - Lack of design audits for process equipment.
  - Wrong maintenance practices
  - Need for proactive maintenance.
  - Need for technical concepts reinforcement at all levels
  - Need for FMECA concept adoption

What mills do? It´s an example

- Lost time indicator analysis
- What are principal causes for breakdown production?
- Root Causes Analysis when is necessary



- Problems whit bagasse moisture and chute donelly feed are no attendant by maintenance staff
- Maintenance staff decide project grate repair for next breakdown scheduled time.



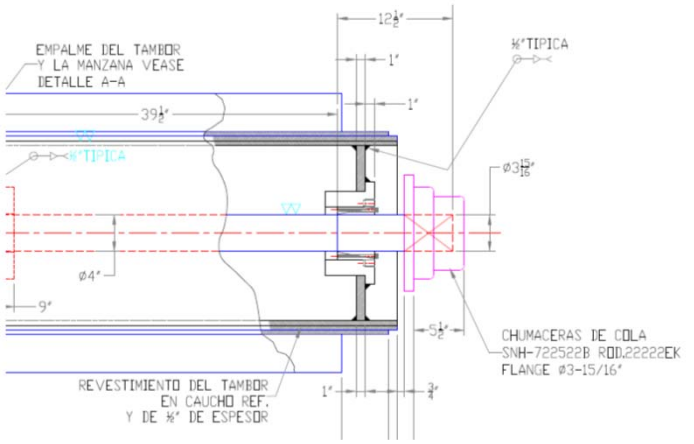
Failure, an unsatisfactory condition

- Failure types:
  - Physical, breakages, high bagasse moisture…
  - Human, wrong practices as bolt torquing, welding, carefulness,
  - Management…the more difficult to deal with…



Crushing mill Intermediate conveyor
Tail drum shaft failure

Root Cause: Use of welding to repair surface of shaft steel (1045) by a external support









Refinery Batch Pan circulator gearbox shaft breakage





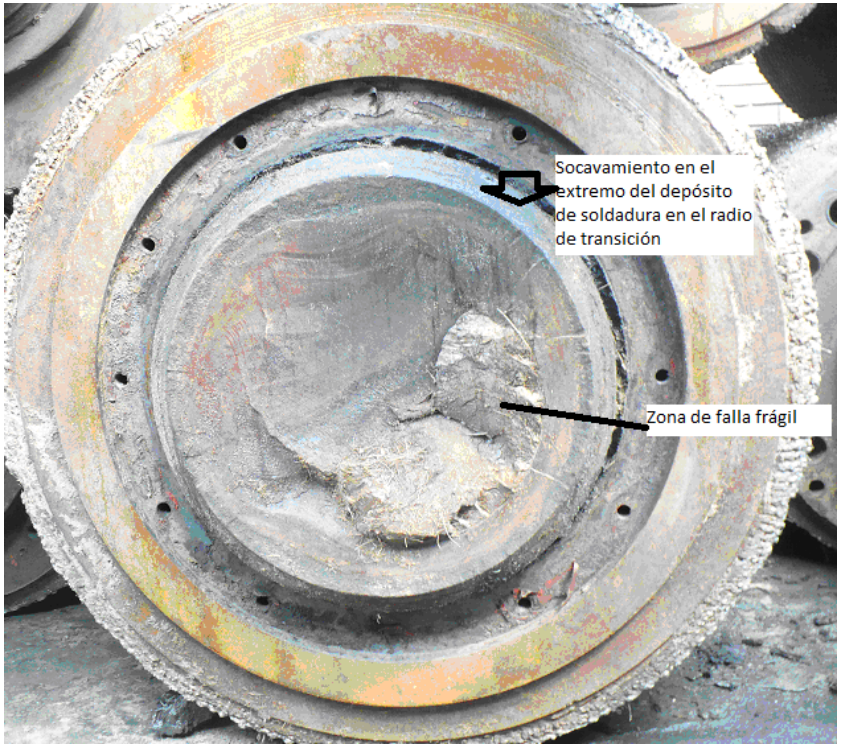
A pin hole was drilled both on the coupling and shaft (to avoid shaft fallind down in the pan) because of bad top bearing box design:

Lack of design audit by the mill on proposed design from local manufacturer





Roll Shafts.





Crack initiation on HAZ of a recovery welding with SS wire. General procedure OK, validated for feed and delivery shafts.

Root cause: HAZ located in the middle of inner journal radius- Sinergy with corrosion

Cane transport Accidents
Lessons learned





Bin accident because of bolted joint failure of turning bearing.
Root cause: lack of torquing, bad adoption of bolt class.





Spindle breakage.
Findings :
•overloaded bins
• Failure can´t be detected by inspection routine.

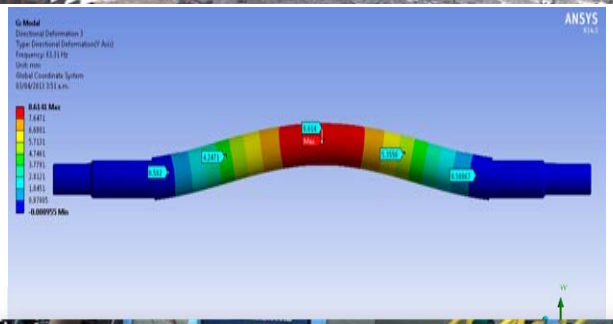




Findings:
•Incorrect Tapered roller bearings preload
•Missing concept, finite fatigue life of roller bearings

Increase power for a Knife Preparation Machine: Lesson learned







- Critical velocity was achieved by a Knife Preparation Machine (1998) at Colombian mill, after power and diameter was increase.
- RAC conducted, show the Critical velocity: **1107 rpm**.

- A second mills project Increase power and diameter machine. Design analysis (FEA) show as Critical velocity should be achieved, also (1074 rpm).
- Knife Preparation Machine have to be checked and changed for a sure condition (**1724 rpm**).

Why RCM?

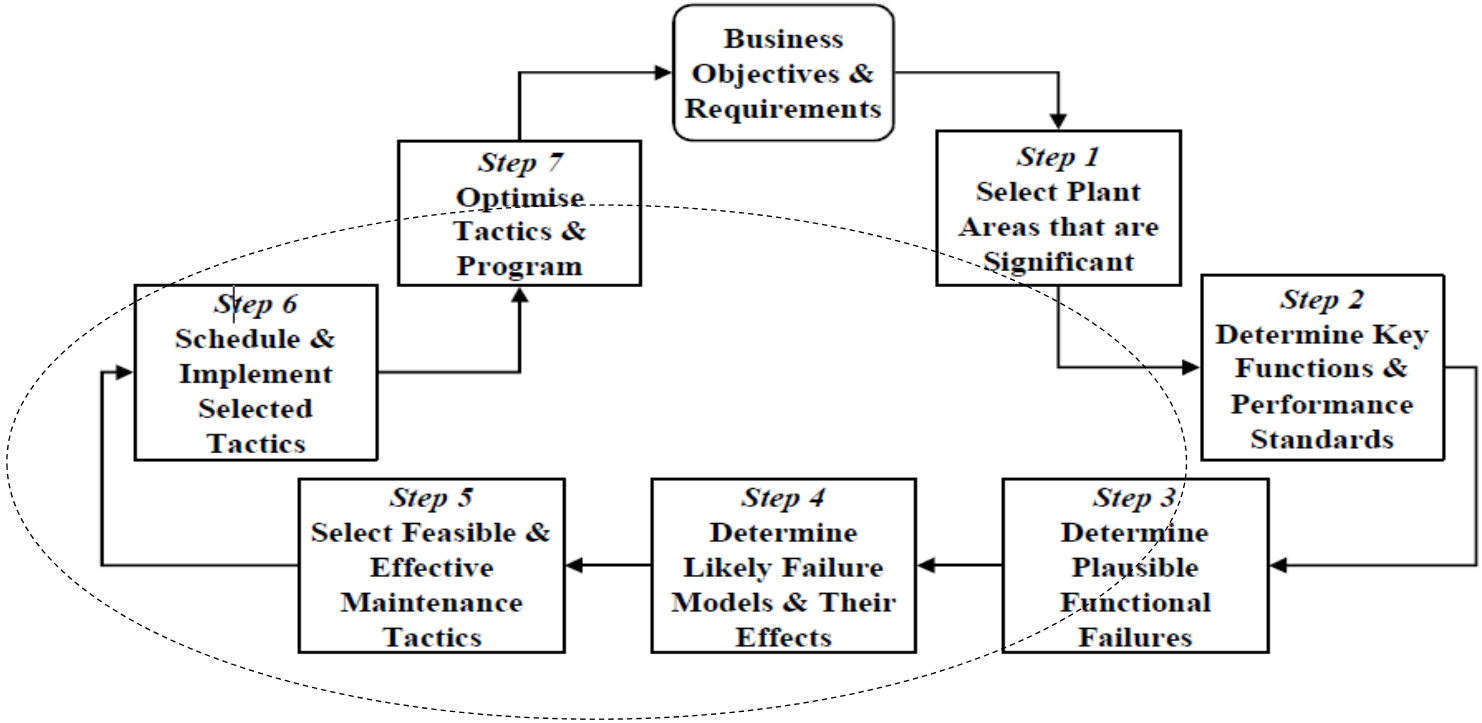
- “A systematic consideration of systems functions, the way functions can fails, an apriority-based consideration of safety and economics that identifies applicable and economics PM task”

  by Electric Power Research Institute

- Reliability Centered Maintenance is a structured, deductive and participative method which define appropieated maintenance strategy for each equipment”

  by Alejandro Pistarelli

Seven steps for RCM, including FMECA (Failure Mode, Effect and Criticality Analysis)



- **RCA** is fundamental as an input from Step 3 through Step 7.
- **FMECA** needs a proactive attitude, is quite different from RCA that is a formal analysis of events. Both are needed in a sound and robust RCM

New Focus: From a comprehensive index to a comprehensive concept and approach to Reliability

- OEE developed out of the need for improvement groups to have a way of measuring and analyzing equipment problems as part of their Define, Measure, Analyze, Improve and Control cycle.
- OEE measures the Availability, Performance and Output Quality of a machine, system or production line…
- In order to achieve OEE targets the three components need RELIABILITY…
- A failure is an unsatisfactory condition…so RCA needs to be applied to the three components
- Consequences of failure determine the orientation, priority and intensity of the efforts of maintenance, production or projects engineering people.
- To be pro-active is a good practice, so FMECA is recommended whenever practical
- FMECA is part of RCM and RCM a part of Asset Management…

Benefits sought…

- Reduced maintenance costs.
- Improve equipment reliability. Reduced/eliminated causes of equipment failures
- Reduced product loss or production downtime due to equipment failure.
- Ensure equipment operates to design specifications.
- Maximize the life of equipment and main components.

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The challenges…

1. **Holistic Reliability**: reliability as a total plant—not only a maintenance problem.
2. **Predictive technologies adopted** toward early detection of any deviation from design.
3. **85% 'World Class Standard'** is an arbitrary target found in the original TPM literature. Sucroenergetic industry needs to develop its own targets
4. **Principal objective**: To provide sustainable:
   - best-in-class performance.
   - Reliability
   - total cost of ownership.

Contractors and tasks…

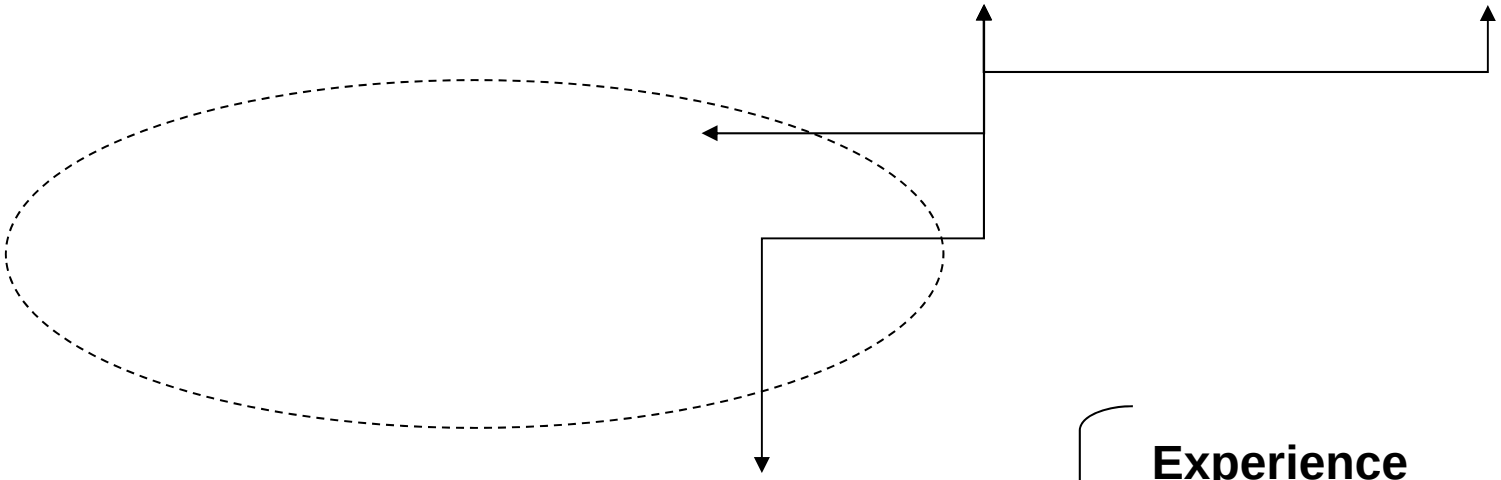
- Contractors and design engineering suppliers, must be able to perform better than mill's own people.
- To change:
  - Contractors receive little follow up
  - Unmanaged contractor activities impact reliability and expense.
  - The mill must be able to describe the results it is seeking from the contractor.
  - Task description must be as precise as possible.
  - Biggest factor affecting the success of a contractor is the planning and preparation made by the mill prior to engaging the resource.

About maintenance structure…

- Typical RCM structures need three sub-structures:
  - **Reliability group**: in charge of predictive or CBM, sometimes of checking quality of supplies or spare parts. Also coordinate RCA and FMECA activities.
  - **Planning team**
  - **Intervention teams** (mechanics, instrument, electricians) well qualified and supplied with the best tools…

- Sucroenergetic Colombian industry crushing during 330 days/year has been conventionally structured and dimensioned for corrective maintenance tasks.
- With the adoption of RCM system, similar or combined structures are envisioned .

Maintenance first structure projected



Experience

Capacitation

Tools and equipment

Projections

- RCM & FMECA tools needs to be developed for mills factories
- Maintenance impact have to be measured and controlled, global indicators is a way to follow
- RCM structure for sugarcane factories have to be defined in accordance whit all interested people.

Acknowledgement

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