Web 101.87SM – Roller Maintenance

The Why/When/How of Roller Repair/Replacement

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Why Repair/Replace?

- Rollers *did* break (unplanned)
- Rollers *might* break (PM)
- Rollers are slowly *wearing out*
  - Cylindricity etc degrading on
    - Forming or Process Rollers
  - Increasing costs of
    - Waste
    - Delay
    - Customer Complaint
    - Etc
Roller Breakage

- Failures
  - Bearings
  - Journals
  - Covers
  - Coatings
- Fortunately uncommon because of hazards
- Read accompanying white paper for details
- Note that PM is also uncommon
Simple Roller Wear Patterns

- Coarse Scale
  - Taper
  - Smile
  - Frown

- Fine Scale
  - Ridge
  - Valley
  - Step
Machine Element Reliability

- The Weibull Distribution

![Weibull Distribution Diagram](https://en.wikipedia.org/wiki/Bathtub_curve#/media/File:Bathtub_curve.svg)
Costs to Repair

$1K/wk

\[ C_{repair} = \frac{C_{down} + C_{regrind} + \frac{C_{replace}}{N}}{t} = \frac{A}{t} \]

Downtime + Regrind + Replace

Time (weeks)
Costs to NOT Repair

Time (weeks)

$1K/wk

Costs to NOT Repair

Waste
Delay
Complaint

Baseline: Other Causes

Not Repair
Optimum Service Interval

Costs To Repair and NOT Repair and Total

Total Cost
Waste
Delay
Complaint
Downtime + Regrind + Replace

Optimum Service Interval

Time (weeks)

$1K/wk
Example Calculation

- Application: paper mill supercalender roll

- Costs to Repair
  - $10,000 downtime etc
  - $10,000 roller regrind
  - $30,000 roller refurbish w 10 regrinds/refurbish

- Costs to NOT repair
  - Corrugations
  - Bagginess
Internal Waste Costs vs Time

$1K/wk

Time (weeks)

Not Repair 4 cycles

Timing of repair

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Waste (etc) Avg & Regression

\[ C = 5.153030808 \cdot 10^{-3} x^2 + 2.902808091 \cdot 10^{-2} x + 5.154889796 \]

\( R = 0.87 \)

Cost to NOT Repair Avg and Regression

\$1K/wk

Time (weeks)

Average  Regression
Minima Using Calculus

- When slopes are equal but of opposite sign
- Solving for roots can be unreal, literally

\[ \frac{dc_{\text{repair}}}{dt} = \frac{A}{t^2} \]

\[ \frac{dc_{\text{NOT repair}}}{dt} = E + 2Ft \]

\[-A + 0Dt + Et^2 + 2Ft^3 = 0\]
Total Cost and Optimum Service Interval

$1K/wk

Time (weeks)

Total Costs

Economic Optimum

Might Notice
Other Opportunities? (After Accounting for *That* Roller)

$1K/wk

Residuals = Fit - Actual

Time (weeks)
Example Summary

- **Optimum service interval**
  - 7-21 weeks via visual minima
  - 14 weeks via polynomial curve fit

- **Minimum total costs**
  - $8,400/week ($436K/yr) of which
  - $5,000 defects *not* associated w calendar wear
  - $1,200 more defects than when brand new
  - $2,200 repair costs
So What?

- It would take 30 weeks for defects to double their minimum rate and be clearly noticed

- $11,100/week at 30 weeks
- $8,400/week at optimum of 14 weeks
- $2,700/week savings using optimum

- $140,000/year for a single key element!
How to Change Roller

• Safely
  – Lock-Out-Tag-Out
  – Scripted plan such as
  – Gantt Chart
  – Take-Two (DuPont)

• Efficiently
  – SMED
  – Scripted plan such as
  – Gantt Chart

• Also consider
  – Spares
  – Grind Quality
  – Storage
  – Rigging

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Other Applications

- **Film**
  - Die cleaning
  - Tower nip replacement

- **Foil**
  - Rolling mill service

- **Paper**
  - Slice maintenance
  - Wire change
  - Felt change
  - Calender roller change

- **Printing**
  - Anilox cleaning
  - Blanket change

- **Slitting**
  - Blade change
Future Study

• More case histories
• Analysis using roots of cubic equation
• Preventative Maintenance
  – Use probability of unplanned downtime as a NOT repair cost
Questions?

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