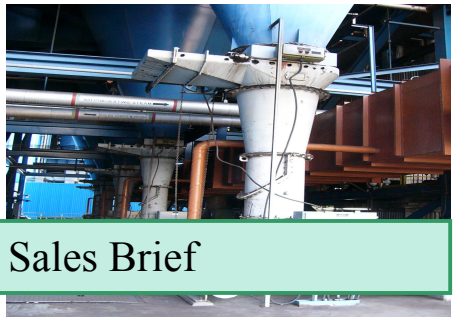
OMDEC

OPTIMAL MAINTENANCE DECISIONS INC



EXAKT Failure Prediction – Sales Brief

OMDEC's Reliability Management Profile – where EXAKT fits

OMDEC's core business is to improve the reliability of our customers' equipment. To do this, we have three main themes – Training, Consulting and Software. Our software portfolio focuses on leading edge software that will help our customers to take major leaps forward in reliability, cost control and maintenance management.

EXAKT is our leading software product; its primary function is to predict the timing and probability of equipment failure based on analysis of multiple condition variables such as working age, oil sediment levels, vibration and so on.

EXAKT draws on data from several customer databases including CMMS/EAM/ERP, Condition Monitoring, SCADA etc. To link EXAKT to these databases and prepare a tailor-made data mart for EXAKT, OMDEC employs Living RCM – an off-the-shelf software package from Bi-Cycle. Together with our well-proven maintenance processes, these form the core of Living Reliability – the main benefits of which are to inter-actively develop a knowledge base for access by analytical tools, and to prompt actual experience to create and update an RCM database, while at the same time, making the RCM knowledge accessible on-line to the work order. And therefore unify the key maintenance knowledge bases and increase maintenance effectiveness.

Purpose of the EXAKT Software

1. A decision support tool for predicting reliability and optimizing Condition-based Maintenance so as to improve reliability, reduce failures and save maintenance costs
2. Applies statistical methodologies to equipment history
3. Identifies the critical variables affecting reliability
4. Predicts equipment failure based on combining multiple equipment condition measurements and correlating them with failure modes
5. Produces a formula for continuous monitoring of failure predictions
6. Estimates remaining useful life of equipment – how long til failure
7. Defines the probability of failure in a given time period
8. Applies statistical confidence levels – how confident are we of our prediction?
9. Defines the mix of preventive replacement and run to failure in order to:
    - Optimize costs
    - Optimize reliability
    - Achieve the optimum balance of risk, cost and reliability.
10. Calculates lead time available to prevent failure

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Target markets

Any organization which:

a. Is Asset Intensive (high value, critical assets).
b. Has a high cost of failure (ie not able to produce the required output; therefore slowdown = failure).
c. Typically will have a CMMS and CBM, sometimes some RCM, often a reliability department and is looking for improvements.
d. Has a history of costly and/or unpredictable breakdowns with complex causes and/or with complex equipment.
e. Ideally multiple equipments of similar type and in similar operating environment; (but single equipments or small data sets are OK)
f. Reasonably good records of breakdowns and maintenance activities

Examples – military, mining, oil & gas, power generation and transmission/distribution, cement, metals and minerals processing, transportation, food processing, chemicals, petrochemicals and plastics, heating and cooling, pharmaceuticals, automotive, batch manufacturing, food and beverage.

Case Studies

1. Haul Truck Motors – Coal Mine

- Project was completed in 2001 on 26 trucks, 55 motors.
- EXAKT reduced Mean Time Before Replacement from 19,700 to 13,500 hours.
- Failures dropped from 100% to 26% (this is the minimum cost level based on the Company's ratio of Replace on Failure cost to Preventive Replacement cost (3:1).
- Maintenance cost for the motors dropped by 25% for an annual savings of $371,000.
- Other commercial benefits not included in the calculations:
  - higher revenues from fewer failures and less downtime
  - reduction in fleet size due to fewer and shorter out-of-service conditions
  - avoidance of contract penalty costs due to non-delivery

2. Circulating Pumps – Liquid Fuel Production

- Project was based on data from 8 pump bearings involving 11 failures.
- Original Replace on Failure policy caused swap outs at 404 days; company had shifted to 215 days to reduce the failure rate. EXAKT recommended 263 days, dropping failures to only 4.
- Annual Replace on Failure cost was $306k versus the cost of the Company's current policy of $261k. EXAKT's recommended policy reduced costs to $162k for savings of $99k compared to the current policy - a cost reduction of 38%.
- Company elected not to include in their cost savings the benefits resulting from:

- Avoidance of contract penalty costs
- Loss of reputation with customers
- Reduced Government penalties due to environmental spills and safety issues

3. Nuclear Fuel Rod Seals

- 30 seals examined with a history of 25 failures.
- Existing policy was Replace on Failure at 657 days – cost was $4.56 per replacement cycle. EXAKT's proposed Preventive Replacement policy reduced this to $3.56 per cycle for a savings of 22%
- Time involved in failure replacement only was considered.
- No commercial benefit was calculated for protecting the revenue stream from power generation losses or loss of reputation as a result of power fluctuations and brown-outs.

4. Gear Boxes

- 11 single reduction helical gearboxes were run to failure on a test-bed
- Comparing failure repair versus preventive replacement costs, the cost saving from applying EXAKT was 33%
- No additional cost data was measured

5. Copper Mine – Haul Truck Motors

- Project was conducted on Rocker Arm Gaskets in the haul truck motor; a sample of 92 with 9 recorded failures was used.
- Replace on Failure policy showed expected time between replacements of 3677 hours, for an annual cost of $26m.
- EXAKT recommended to replace on 2705 hours for an annual cost of $20m
- Annual cost reduction is 23% or $6m
- EXAKT data was extracted from Mincom Ellipse

6. Chemical Processing Plant – Compressors

- Equipment was two stage hydrogen compressor for petroleum feedstocks production – sample size was 45 with 37 failures. Data was extracted from Datastream MP2.
- The Final Report said "EXAKT established the links between CBM data and failure; confident failure predictions and optimized maintenance decisions using EXAKT will be possible shortly"

7. Long Distance Trucking Company – Turbochargers

- Company transports refrigerated foods in hot desert climate - "On Time, On Temp" policy commands a premium
- Reliability Knowledge Base (RKB) was created via a hot link from their Fleet Management System to RCM database and CBM analysis.
- Initial analysis of RKB applied to a sample of 7 failures in turbo impellers.

- Phase 1 results show inexact correlation between failure and run time; phase 2 is testing the correlations with oil sample analysis, running temperatures, load etc.
- Expected commercial results will focus on benefits of predicting and avoiding failure:
  - Avoiding towing charge – one recent failure had a tow-cost of $14,000
  - Protection of "On Time, On Temp" revenue premium and reputation
  - Market growth opportunity from publicity resulting from high quality failure prediction and delivery with confidence
  - Better use of existing equipment through elimination of stand-by units
  - Avoidance of penalties from spoiled and unfrozen customer deliveries

8. Food Processing Company – Shear Pump Bearings

- 21 condition variables monitored; only 3 had a significant impact on the failure mode
- This resulted in a "significant reduction in data collection and analysis costs"
- EXAKT's preventive replacement recommendation led to 55% reduction in costs compared to the Company's practice of Replace on Failure
- Preventive replacement led to a 10% increase in equipment life and a corresponding reduction in capital cost

9. Light Rail Transit System – Wheel Bearings

- Company had excessive failures of traction motor bearings – up to 9 per year.
- Bearing failures cause serious loss of confidence in rider safety.
- EXAKT added one critical variable to be monitored – bearing grease colour and recommended the Inspection Interval be reduced from 3.5 years to 1 year
- EXAKT recommendations:
  - reduced the units' maintenance costs by 55%
  - reduced failures from 9 to 1
  - reduced CBM data collection costs by $3m annually

10. Pulp Mill – Pump bearings

- 33 bearing histories were examined in 8 pump locations, including 11 failures.
- EXAKT recommendations would have prevented 10 of 11 failures by reducing the Mean Time Between Replacement from 571 to 529 days.
- This resulted in a cost saving of over 30% based on a ratio of Preventive Replacement cost to Replace on Failure cost of 1:3
- no account was taken of revenue protection caused by the lower failure rate or of damage to reputation from environmental spills

11. Diesel Engines – UK MOD

- 108 diesel engines in the fleet, manufacture date 1982 to 1985
- 5 of 9 failure modes proved; 5 were predictable from oil analysis.
- Human expert allowed 83 failures and performed 28 preventive replacements
- EXAKT recommended 171 preventive replacements and allowed 3 failures
- "On the evidence of this test, EXAKT is better than an Expert" – MOD Project Manager

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Benefits

- **Production Reliability** is improved and operating costs reduced by predicting and avoiding failures.
- **Equipment Downtime** can be eliminated before the end of the production run, providing operations with a high level of confidence
- **Maintenance Scheduling** becomes much more accurate through predicting remaining useful life
- **Analysis of low-impact data** can be eliminated by directly relating the significant condition variables to failure modes
- **Maintenance costs** are reduced by optimizing the frequency of preventive replacements
- **Failure costs** are reduced by balancing run to failure against preventive replacements
- **Failure Prediction** now becomes an easily accessible science for complex equipment, by operating at the component level
- **Equipment and component replacement planning** is greatly improved through accurate prediction of remaining useful life
- **Prediction models** become consistent and accurate for each piece of equipment
- **Data analysis costs** are reduced by focusing on key operating and condition variables which have predictive capability
- **Results at a glance,** from easy to read graphs requiring minimum training
- **System maintenance** is minimized through self-checking analyser that ensures the on-going accuracy of the statistical formulas
- **Decision making** is improved leading to more uptime and lower costs
- Based on **proven algorithms**, designed and developed by the University of Toronto
- **Complementary to RCM**
- **Worldwide Sales and Support** by OMDEC and Partners
- Web **Training** included; comprehensive **User manual**
- Runs on **Windows** laptop/desktop

Inputs

EXAKT works by correlating measurable condition variables with failure modes. It also eliminates low impact variables – ie those that have little or no impact on the predictability of the failure. Consequently, EXAKT can use data from a wide variety of condition variables – vibration, oil analysis, thermography, acoustic and so on. These data are transferred from the data collection system to create an Event Table in EXAKT. Also needed for the Event Table are the dates of these measurements, plus those of other events that will be used for the reliability analysis that EXAKT performs. These will include oil changes, changes in operating patterns, maintenance interventions, component replacements etc – most of which will be available from the CMMS Work Order database.

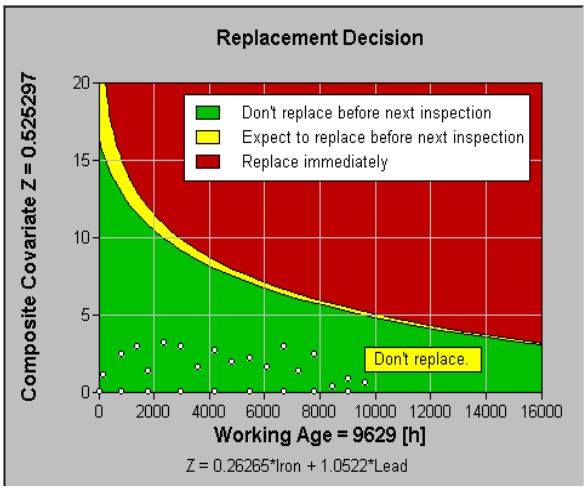
These data can be directly keyed into the EXAKT event table. Where the data is extensive, the LRCM software module (Living Reliability Centred Maintenance), acts as the data pre-

processor. It interfaces directly with the CBM and CMMS databases to extract the appropriate data and load it into the EXAKT Event Table.

Another key data input required is the relationship between the cost of failure and the cost of a preventive replacement. This CR (Cost Ratio) is used by EXAKT to determine the optimum balance of maintenance activities.

Outputs

The key output reports from EXAKT are the well-known traffic-light charts – two examples of which are shown below:



In each case, the dotted line tracks the readings calculated by model using the algorithm developed by EXAKT. While the results are plotted in the green zone, no maintenance action is required before the next maintenance intervention. Once the red zone is reached, then the cost and risk is such that immediate maintenance intervention is recommended. If the latest plot is in the narrow yellow zone, then no immediate action is needed, but intervention is recommended before the next schedule maintenance work.

A sample of the EXAKT cost report follows:

Summary of Cost Analysis

	Cost [$/hr]	Preventive Repl. Cost [$/hr]	Failure Repl. Cost [$/hr]	Prev. Repl. [%]	Failure Repl. [%]	Expected Time Between Replacements
Optimal Policy	3.06514	1.92481 (62.8 %)	1.14034 (37.2 %)	91.0	9.0	9456.87
Replacement Only At Failure	6.09151	0 (0.0 %)	6.09151 (100 %)	0.0 %	100.0 %	19699.5
Saving	3.02637 (49.7 %)	-1.92481	4.95118	-91.0 %	91.0 %	-10242.7

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In this cost report, we can see that the current policy of replacement only on failure results in a cost of $6.09 per hour, and an expected time between replacements of 19,699 operating hours. Using the EXAKT minimum cost methodology, this can be reduced by almost 50% to $3.06 by increasing preventive replacements and reducing the expected time between replacements to 9,456 operating hours. This results in a 91:9 preventive to failure ratio. Further reduction of this 9% failure ratio is not recommended as this will increase the overall cost.

Delivery Options

1. Conference Room Pilot (CRP) – to demonstrate software capabilities and benefits using customer data
    a. Phone/email discussions to select target equipment
    b. Data transfer to OMDEC
    c. Data cleansing, analysis and model building by OMDEC
    d. On-site presentation of software capabilities, demonstration of results, and discussion of opportunities and next steps

2. On-site Pilot – beyond CRP to provide training in reliability and hands-on use of EXAKT, including model building and system operation
    a. Select target equipment
    b. Install demo system on client PC
    c. Review data with client, training and practice in data cleansing techniques
    d. Reliability and EXAKT training
    e. Hands-on EXAKT model building
    f. Preparation and discussion of results and further opportunities
    g. Presentation and demonstration of results

3. Full System Implementation – as On-site Pilot except:
    a. Live system install – single or multi-user
    b. Multiple training and model building sessions
    c. Application to multiple equipments
    d. On-going training, coaching, support and upgrades

4. EXAKT On-line
    a. Selection of equipment and data to be collected
    b. Initial training in concepts and requirements
    c. Set up data transfer mode (connection to secure website for example)
    d. Customer supplies data on regular basis to OMDEC
    e. OMDEC analyzes, sends feedback report, builds new models as needed
    f. System operation, software support and maintenance managed by OMDEC

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Training and Support

The software requires a short training program of about a week – typically delivered on-site at the time of implementation. Some practice is required in the model building but OMDEC staff are available on an on-going basis to develop and maintain new models if preferred. Web seminars are also available, as are self-running tutorials.

Upgrades will be available from time to time as new features and capabilities are added.

Training and Support is provided by OMDEC or certified partners. Technical support is provided by OMDEC.

Software and Support Pricing

OMDEC price list. Special offers available from time to time.

Demo

Readily available - Contact your regional manager

How to Order a Full Copy

Just send us an email or call, we will do the rest.

Further Documents Available

Brochures and Case Studies available from the OMDEC website www.omdec.com.
EXAKT tutorials and many white papers also on **www.omdec.com**.
PowerPoint presentations
Detailed technical discussions available - contact your regional manager.

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